

DEPARTMENT OF AGRICULTURE,
CEYLON.

BULLETIN No. 57.

**A CONTRIBUTION TO THE STUDY OF THE
PADDY SOILS OF CEYLON AND
EASTERN COUNTRIES.**

By ALEXANDER BRUCE, B.Sc., F.R.S.E.

Peradeniya,
December, 1922.

COLOMBO:
H. R. COTTLE, GOVERNMENT PRINTER, CEYLON.

1922.

DEPARTMENT OF AGRICULTURE.

Administration:—

Hon. Mr. F. A. STOCKDALE, M.A., F.L.S. Director of Agriculture.
 E. ALUWHARE Office Assistant.
 B. H. PERERA Chief Clerk.

Research—Laboratories:—

T. PETER, B.A., B.Sc. .. Botanist and Mycologist.
 J. C. HUTSON, B.A., Ph.D. .. Entomologist.
 E. O. IFFERT, B.A. .. Economic Botanist.
 M. K. BAMBER, M.R.A.C., F.I.C., F.C.S. Agricultural Chemist.
 G. BRYCE, B.Sc. .. Assistant Botanist and Mycologist.
 O. H. GADD, B.Sc. .. Assistant Mycologist.
 F. P. JEPSON, M.A., F.R.S. Assistant Entomologist.

Research—Plant Pest and Disease Inspectorate:—

N. K. JARDINE, F.R.S. .. Inspector for Plant Pests and Diseases.
 .. Central.
 A. T. RERYE, A.B.C.S. .. Inspector for Plant Pests and Diseases.
 .. Southern.

Research—Experiment Stations:—

T. H. HOLLAND, Dip., Agr., Wye. .. Manager, Experiment Station, Peradeniya.

Agricultural Branch:—

G. G. AUGHLIN, M.Sc., A.I.C., F.C.S. Divisional Agricultural Officer, Central.
 N. MARSHALL, B.Sc. .. Divisional Agricultural Officer, Northern.
 G. HARBORD .. Divisional Agricultural Officer (on leave).
 F. BURNETT, B. Agr. .. Divisional Agricultural Officer, Southern.
 H. A. DEUTROM .. Manager, Experiment Station, Anuradhapura.

Gardens Branch:—

H. F. MACMILLAN, F.R.H.S., F.L.S. .. Superintendent of Botanic Gardens.
 T. H. PARSONS .. Curator, Royal Botanic Gardens, Peradeniya.
 J. J. NOCK .. Curator, Hakgala Gardens.

BOARD OF AGRICULTURE.

EXECUTIVE COMMITTEE.

His Excellency the Governor, <i>President</i> .	Mr. O. C. Tillockaratne.
The Hon. the Colonial Secretary, <i>Vice-President</i> .	The Hon. Lieut.-Colonel T. Y. Wright.
The Hon. the Controller of Revenue.	Mr. R. G. Coombe (on leave)
The Director of Agriculture.	Mr. W. A. de Silva.
The European Rural Member of Council.	Mr. J. B. Coles.
The Hon. Dr. H. M. Fernando.	Mr. C. E. A. Dias (on leave), F. R. Senanayake (acting).

Secretary: Mr. R. Aluwthare.

Ex Officio Members.

The Government Agent, Western Province.	The Government Agent, Northern Province.
The Government Agent, Central Province.	The Government Agent, North-Western Province.
The Government Agent, Southern Province.	The Director of Irrigation.

ESTATE PRODUCTS COMMITTEE.

The Director of Agriculture (<i>Chairman</i>).	Dr. C. A. Hewavitarne (on leave).
Mr. H. L. de Mel, C.B.E.	W. M. C. Dias Bandaranaike (acting).
Mr. J. Graeme Sinclair.	Lieut.-Col. T. G. Jayawardene.
Mr. James Pelris.	Mr. E. W. Keith.
Sir S. D. Bandaranayake, C.M.G.	Mr. A. S. Long-Price.
The Chairman, Planters' Association of Ceylon.	Mr. A. C. Mathew (on leave), Mr. W. R. Mathew (acting).
The Chairman, Low-country Products Association.	Mr. T. A. de Mel.
Mr. A. J. Austin Dickson.	Mr. J. W. Oldfield.
Lieut.-Col. L. Bayly.	Mr. Graham Pandittasekera.
Mr. A. W. Ewen.	Mr. L. H. S. Pieris.
Mr. George Brown.	Mr. A. E. Rajapakse, Gate Mudaliyar.
Mr. D. S. Cameron.	Mr. F. R. Senanayake.
Mr. N. G. Campbell.	Mr. N. D. S. Silva.
Mr. J. B. Coles.	Mr. S. E. Hamer.
Mr. R. G. Coombe (on leave), Mr. J. Horstall (acting).	Mr. A. P. Waldoock.
Mr. C. E. A. Dias* (on leave), A. M. C. Dias (acting).	Mr. M. L. Wilkins.
Mr. R. Garnier.	The Hon. Lieut.-Col. T. Y. Wright.
Mr. H. D. Garrick.	Mr. M. Kelway Bamber, Government Agricultural Chemist.
Mr. A. P. Goonetilleke.	The Botanist and Mycologist.
	The Entomologist.
	The Assistant Botanist and Mycologist.
	The Assistant Entomologist.

Secretary: Mr. T. H. Holland.

For Food Products Committee see page 3 of cover.

DEPARTMENT OF AGRICULTURE, CEYLON.

BULLETIN No. 57.

A CONTRIBUTION TO THE STUDY OF
THE PADDY SOILS OF CEYLON
AND EASTERN COUNTRIES.

By ALEXANDER BRUCE, B.Sc., F.R.S.E.



ALTHOUGH the area under rice cultivation extends to about 700,000 acres, the crops are insufficient to feed the inhabitants of the Island, and consequently large sums are spent on importing the staple diet from neighbouring rice-growing countries.

With the view to assisting in the question of greater local production of paddy, soils from the different Provinces of Ceylon have been examined, the results of which determine one of the factors, whether the area under the cultivation of paddy can be extended economically and indicate the cultivation required for existing and potential paddy lands.

Soil samples have been obtained from the Southern, Central, North-Western, North-Central, Northern, and Eastern Provinces of Ceylon. A total of 54 samples were examined. For purposes of comparison, soils have been obtained from the chief rice-growing countries of the East: Burma, India, Federated Malay States and Straits Settlements, Siam, Philippines, and Japan. Sixty-five samples were examined from these countries, making a total of 119 samples examined for the purpose.

The following details were called for: (1) Other produce interplanted; (2) elevation; (3) rainfall; (4) climate; (5) texture of soil, hard or loose; (6) irrigation given; (7) condition of plants; (8) yield per acre; (9) if manured, artificial or green; (10) if rotation of crop practised; (11) if seed is broadcasted or transplanted, and quantity per acre; (12) if ordinary seed used or selected; (13) variety of paddy; (14) diseases, &c.

Soil samples were taken from surface to 9 in.-18 in.-24 in. from several places and mixed.

The method of analyses used is that adopted by the Committee of Agricultural Education Association.

The report can be considered only a preliminary to the subject of Ceylon paddy soils, and is based on samples and details obtained.

Ceylon.

Southern Province.															West- ern Pro- vince.
Gal- le Dis- trict.	Matara District.						Hambantota District.								Water absorption 3 mm.
	Kotagama Field, Bilaboda.	Kaithala Field, Korale.	Thibagoda Field, Control Plot.	Thibagoda Field, Poor Soil.	Narandala Field, Rich Soil.	Nugewa Tract of Fields.	Weli- gam Korale.	Thissa No. 1.	Thissa No. 2.	Thissa No. 3.	Thissa No. 4.	Thissa No. 5.	Thissa No. 6.	Thissa No. 7.	
1	6.07	14.10	4.90	4.80	6.30	3.23	7.50	3.66	3.85	3.95	3.94	2.50	2.70	3.90	2.43
2	9.25	35.70	6.47	8.87	11.08	3.71	13.72	2.89	5.02	5.83	6.98	9.87	4.40	3.92	4.43
3	23.00	72.20	31.98	31.60	32.83	21.11	22.44	15.33	15.88	21.43	18.46	13.25	10.52	24.33	6.09
4	13.13	6.70	9.80	12.95	17.50	7.76	12.55	8.00	6.43	6.29	8.00	4.40	6.40	17.32	28.69
5	6.02	1.70	4.84	6.40	0.34	9.40	13.75	31.15	32.45	37.58	23.50	25.94	39.60	30.63	30.63
6	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
7	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
8	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
9	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
10	68.00	62.00	68.00	68.00	58.00	66.00	80.00	61.00	61.00	59.00	66.00	61.00	54.00	56.00	66.00
11	70.00	62.00	68.00	68.00	58.00	66.00	80.00	61.00	61.00	59.00	66.00	61.00	54.00	56.00	66.00
12	70.00	62.00	68.00	68.00	58.00	66.00	80.00	61.00	61.00	59.00	66.00	61.00	54.00	56.00	66.00
13	70.00	62.00	68.00	68.00	58.00	66.00	80.00	61.00	61.00	59.00	66.00	61.00	54.00	56.00	66.00
14	70.00	62.00	68.00	68.00	58.00	66.00	80.00	61.00	61.00	59.00	66.00	61.00	54.00	56.00	66.00
15	70.00	62.00	68.00	68.00	58.00	66.00	80.00	61.00	61.00	59.00	66.00	61.00	54.00	56.00	66.00
16	70.00	62.00	68.00	68.00	58.00	66.00	80.00	61.00	61.00	59.00	66.00	61.00	54.00	56.00	66.00
17	70.00	62.00	68.00	68.00	58.00	66.00	80.00	61.00	61.00	59.00	66.00	61.00	54.00	56.00	66.00
18	70.00	62.00	68.00	68.00	58.00	66.00	80.00	61.00	61.00	59.00	66.00	61.00	54.00	56.00	66.00
19	70.00	62.00	68.00	68.00	58.00	66.00	80.00	61.00	61.00	59.00	66.00	61.00	54.00	56.00	66.00
20	70.00	62.00	68.00	68.00	58.00	66.00	80.00	61.00	61.00	59.00	66.00	61.00	54.00	56.00	66.00

Composition.		3-000	4-000	8-400	3-540	3-900	4-600	2-900	4-900	3-200	3-120	3-840	3-300	3-720	2-800	2-300	5-000	2-400
Moisture		13-340	26-000	46-000	16-400	19-500	27-600	14-800	20-100	0-080	6-300	6-600	8-780	10-000	4-600	6-700	11-400	15-200
Calcium		24-240	4-080	3-900	3-700	3-2100	2-100	4-240	4-320	4-960	5-120	5-760	4-640	4-940	2-720	3-280	3-000	2-000
Sulphuric acid		24-240	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530
combined water		24-240	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530
Oxide of iron and		24-240	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530
manganese		24-240	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530
Oxide of alumina		24-240	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530
Lime		24-240	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530
Magnesia		24-240	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530
Potash		24-240	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530
Sulphuric anhydride		24-240	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530
Phosphoric acid		24-240	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530
Chlorine		24-240	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530
Glycerine		24-240	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530
Lower oxide of iron		24-240	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530
Equal to ammonia		24-240	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530
Reaction, F. H.		24-240	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530
Citric soluble phos-		24-240	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530
phoric acid		24-240	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530
Citric soluble potash		24-240	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530	2-530

Table I.

(4)

Serial No.	Coarse.	Silt.	Clay.	Water Absorp. tion.	Nit.	Lime Cao.	Magnesia Mgo.		Potash K ₂ O		Citric Phos. Acid		Yield per Acre, lb.
							Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	
SOUTHERN PROVINCE.													
Galle District	1	33	36	23	68	0.230..	0.200..	0.087..	0.154..	0.010..	0.128..	0.014..	Maha, 540, Yala 108
Do.	2	8	46	29	70	0.310..	0.400..	0.101..	0.185..	0.023..	0.083..	0.018..	Maha, 1,494
Do.	3	2	24	24	62	1.221..	0.080..	0.056..	0.193..	0.010..	0.154..	0.018..	Maha, 778; Yala 510
Do.	4	7	61	30	68	0.291..	0.120..	0.086..	0.255..	0.009..	0.179..	0.010..	390-450
Do.	5	1	34	33	68	0.456..	0.200..	0.114..	0.173..	0.012..	0.256..	0.019..	3,370-4,500
Do.	6	1	34	33	68	0.456..	0.200..	0.114..	0.173..	0.012..	0.256..	0.019..	540-675
Do.	7	25	29	32	66	0.252..	0.260..	0.173..	0.139..	0.009..	0.116..	0.008..	1,464
Do.	8	25	35	18	80	0.868..	0.120..	0.115..	0.154..	0.011..	0.179..	0.015..	990-1,260
Average	—	15	38	26	67	0.579..	0.193..	0.109..	0.176..	0.012..	0.168..	0.014..	1,464
Hambantota District													
Do.	9	61	23	9	60	0.240..	1.500..	0.168..	0.532..	0.015..	0.320..	0.010..	900
Do.	10	56	22	6	61	0.113..	1.360..	0.784..	0.896..	0.038..	0.230..	0.014..	900
Do.	11	60	24	7	66	0.113..	1.360..	0.784..	0.896..	0.038..	0.256..	0.015..	1,350-1,575
Do.	12	60	27	10	59	0.280..	1.460..	1.037..	0.540..	0.034..	0.192..	0.013..	990-1,260
Do.	13	56	17	19	61	0.268..	0.700..	0.576..	0.419..	0.013..	0.154..	0.012..	676
Do.	14	55	17	4	54	0.957..	0.380..	0.475..	0.272..	0.010..	0.154..	0.015..	360-450
Do.	15	75	16	4	56	0.957..	0.380..	0.475..	0.272..	0.010..	0.154..	0.015..	360-450
Do.	16	43	31	14	56	0.235..	0.380..	0.446..	0.310..	0.010..	0.205..	0.017..	1,576-1,800
Average	—	62	22	9	58	0.188..	0.938..	0.513..	0.459..	0.024..	0.118..	0.014..	1,464
WESTERN PROVINCE.													
Kalutara District.	17	52	34	6	60	0.342..	0.140..	0.087..	0.170..	0.0085	0.154..	0.014..	900

Serial No.	District.	Elevation.	Rainfall.	Irrigation.	Yield per Acre, lb.	Manures.	Broadcasted or Transplanted.	Quantity of Seed.	Variety.
SOUTHERN PROVINCE.									
1	Galle	60 ft.	100-150 in.	Yes	"Maha" 510 "Yala" 405	Bone dust in small quantities	Broadcasted	90 lb.	Bala Mahaw
2	Matara	"	"	Yes	"Maha" 1,494 "Yala" —	1 cart bone meal and citronella ash	do.	90 lb.	Karaya
3	Matara	30 ft.	"	Rainwater	"Maha" 778 "Yala" 510	"Maha" bones "Yala" Paddy mixture	do.	90 lb.	Maha : Yala : Karaya
4	Matara	30 ft.	71-02 in.	Tank	"Maha" 675	—	do.	113 lb.	Madoluwa : Yala : Karaya
5	Matara	30 ft.	71-03 in.	Tank	"Maha" 360-450	—	do.	113 lb.	Madoluwa : Yala : Karaya
6	Matara	35 ft.	71-02 in.	No	3,370-4,600	—	do.	113 lb.	Madoluwa : Yala : Karaya
7	Matara	10 ft.	72-02 in.	Yes	540-675	1 to 1 cart load of citronella ash per acre	do.	90 lb.	Mawi and Bala Mawi
8	Matara (Wellgam Korale)	40 ft.	"	Tank	743	Previous manure dust with bone	do.	90 lb.	Gulkutta
9	Hambantota	10 ft.	38-10 in.	Tank	990-1,260	"Yala" Fish Guano 64 lb. Bone 100 lb. Mircham 40 lb.	do.	113 lb.	Maha Suduwi and Karaya
10	Hambantota	10 ft.	38-10 in.	Tank	900	—	do.	113 lb.	do.
11	Hambantota	10 ft.	38-10 in.	Tank	1,350-1,675	—	do.	113 lb.	do.
12	Hambantota	10 ft.	38-00 in.	Tank	900-1,260	—	do.	113 lb.	Maha-Suduwi
13	(Magam Pattu)	8 ft.	38-10 in.	Tank	900	—	do.	113 lb.	Heenati
14	Hambantota	8 ft.	38-10 in.	Yes	675	—	do.	113 lb.	Rudrasayal and Dalpa
15	Hambantota	6 ft.	38-10 in.	Yes	360-450	—	do.	113 lb.	do.
16	Hambantota	12 ft.	38-10 in.	Yes	1,075-1,800	—	do.	113 lb.	Ratkaraya and Suduwi
WESTERN PROVINCE.									
17	Kalutara	20 ft.	100 in.	Rain	900	Manured with cow dung	do.	90 lb.	Hondarawala

SOUTHERN PROVINCE.

Galle-Matara District.

(Tables I, and A.)

Soils from Galle-Matara District (8 examined) have more clay and silts than the other districts in Ceylon, and have a higher water holding capacity. There is only one Galle soil and it is similar to Matara soils (Nos. 2-8) in the following particulars; in mechanical composition (Nos. 7 and 8); in chemical composition, nitrogen (Nos. 4 and 7), lime (Nos. 5, 6, and 7), magnesia (Nos. 2, 3, and 4), potash (Nos. 5 and 8), phosphoric acid (Nos. 3, 6, and 8). Some of the Matara soils (Nos. 2, 3, 5, 6, and 8) might be called "muck" soils. They are laden with organic matter, which increases the water-holding power. They are a distinctive type of soil peculiar to the district, and considered one of the finest paddy areas in Ceylon. Soils from other countries do not possess this type of soil, at least for rice growing.

The average for the district in water-holding capacity is 67 per cent., with a maximum of 80 per cent. in No. 8 and a minimum of 58 per cent. in No. 6.

The coarse material, including gravel and sands, averages 15 per cent., with a maximum of 33 per cent. in No. 1 and a minimum of 2 per cent. in No. 3. The silts averages 38 per cent., with a maximum of 51 per cent. in No. 4 and a minimum of 24 per cent. in No. 3. The clay usually poor in Ceylon soils, averages 26 per cent. with a maximum of 33 per cent. in No. 5 and a minimum of 18 per cent. in No. 8.

The organic matter being rich in these soils, the nitrogen is expected to be high. The average is 0.579 per cent. the maximum 1.221 per cent. in No. 3, and the minimum 0.230 per cent. in No. 1. The former represents the "muck" soil type. Lime is generally poor in Ceylon soils, except where coral or dolomite outcrops occur. The maximum in these soils 0.40 per cent. (No. 2) is high, and is probably due to coral; the minimum is 0.08 per cent. in No. 3. The low percentage is due to the acidity dissolving out the lime in this "muck" soil. The average lime is 0.195 per cent. Magnesia is poor in the district. The average is 0.11 per cent., the maximum 0.173 per cent. in No. 7, the minimum 0.058 per cent. in No. 3. Potash is comparatively poor, the average is 0.176 per cent., the maximum 0.255 per cent. in No. 4, the minimum 0.139 in No. 7. The average available potash is 0.0112 per cent., the maximum 0.023 per cent. in No. 2, the minimum 0.006 per cent. in No. 5. Phosphoric acid is generally poor in Ceylon soils. In these soils the supply is fair, averaging 0.156 per cent., with a maximum of 0.256 per

cent. in No. 6 and a minimum of 0.083 per cent. in No. 2. The available phosphoric acid averages 0.014 per cent., the maximum 0.019 per cent. in Nos. 3 and 6, the minimum 0.008 per cent. in Nos. 5 and 7.

The acidity varies from P. H. 4.5 in No. 3 to P. H. 7.8 in No. 8. The "muck" soils are all acid. The others are approximately neutral.

Elevation varies from sea level to 60 feet at Galle. Rainfall varies from 72 inches in the Matara District up to 150 inches in the Galle District. Irrigation is given when necessary.

Seed is broadcasted at the rate of 90-113 lb. per acre; selected seed is not used. A number of different varieties are used for sowing. Crops vary from 360-4,500 lb. per acre. One or two crops are taken depending on whether irrigation water is available or not.

Several of the areas have been manured. No. 1 with bones, a favourite manure for paddy. No. 2, bone meal 1 cwt., and also citronella grass ash, the pure ash has a high potash content. No. 3, bone meal and paddy mixture. No. 7, a bullock cart of citronella ash. No. 8, bone dust and 2 cwt. paddy mixture. The manuring experiments at present carried on will determine definitely the quantity and form of intensive cultivation required.

Hambantota District.

Soils from Hambantota District (8 examined) are a much coarser type than those examined from Matara direct. The coarse material varies from 45 per cent. in No. 16 to 75 per cent. in Nos. 14 and 15; this includes sands and gravels, the bulk of the coarse is due to the sands. The average is 62 per cent.

Silts average 22 per cent., with a maximum of 31 per cent. in No. 16 and a minimum of 16 per cent. in No. 15.

Clay varies from 4 per cent. in Nos. 14 and 15 to a maximum of 19 per cent. in No. 13. Average 9 per cent.

Water-holding capacity averages 58 per cent. with a maximum of 66 per cent. in No. 12 and a minimum of 50 per cent. in No. 15.

The coarse material is higher than the Galle Matara District by 47 per cent. The silts are lower by 16 per cent. The clay is lower by 17 per cent. Water absorption lower by 9 per cent.

Nitrogen averages 0.188 per cent., with a maximum of 0.280 per cent. in No. 12 and a minimum of 0.056 per cent. in No. 14. Lime varies from the maximum of 1.5 per cent. in No. 9 to a minimum of 0.38 per cent. in Nos. 15 and 16. The average is 0.938 per cent. These percentages of lime are

high for Ceylon soils. Magnesia averages 0.513 per cent., with a maximum of 1.037 per cent. in No. 12 and a minimum of 0.158 per cent. in No. 9. Potash is generally rich, and averages 0.45 per cent., with a maximum of 0.695 per cent. in No. 11 and a minimum of 0.232 per cent. in No. 14. The available potash averages 0.0206 per cent., with a maximum of 0.038 per cent., in No. 11 and a minimum of 0.009 per cent. in No. 14. Phosphoric acid averages 0.178 per cent., with a maximum of 0.256 per cent. in No. 11 and a minimum of 0.102 per cent. in No. 9. The available phosphoric acid averages 0.014 per cent., with a maximum of 0.017 per cent. in Nos. 13 and 16 and a minimum of 0.010 per cent. in No. 9.

The Hambantota soils have less fine soil for the plants to feed on, but the fine soil is much richer in mineral plant food than the Galle-Matara soils, the latter are richer in organic matter and nitrogen.

Nos. 9, 10, 11, 12, 14, and 15 are alkaline. Nos. 13 and 16 are acid. Elevation is from 6 feet to 12 feet.

Rainfall averages 38 inches per annum. Irrigation of the fields is carried out.

Ordinary—unselected—seed is broadcasted at the rate of 90 to 113 lb. per acre. The yield varies from 360 to 450 lb. per acre in No. 15 to 1,575 to 1,800 lb. per acre in No. 16. The average works out at 1,028 lb. per acre, nearly 40 lb. per acre less than the Galle-Matara District, the average of which is brought up by No. 6. Eliminating No. 6 from the average, the figure 750 is obtained for the Galle-Matara District, which is lower than the average (1,028 lb.). Hambantota District, in which no artificial manuring had been carried out, taking this into consideration, is considered a better yielder than the Galle Matara District.

WESTERN PROVINCE.

Kalutara District.

Only one sample was obtained from the Western Province—the Kalutara District—Raygam. The soil is a gravelly loam, with 8 per cent. coarse gravel. The coarse material amounts to 52 per cent., silts to 34 per cent., clay to 6 per cent., water-holding capacity to 60 per cent., in many respects similar to the Hambantota soils, but with a greater supply of silts. The nitrogen is greater, amounting to 0.342 per cent. The mineral plant food is generally poor. The yield, 900 lb. per acre, is considered fair under the conditions. Ordinary seed was broadcasted at the rate of 90 lb. per acre, and the fields were manured with $\frac{1}{2}$ cwt. bone dust.

Elevation is 20 feet, with a rainfall of 100 inches.

Central Province.
Alagalla-Pasadeniya District.

North-Western Province.
Kurunegala District.

Serial No.	Central Province.				North-Western Province.			
	Alagalla-Pasadeniya District.				Kurunegala District.			
	A	B	C	Rich.	Poor.	Hiripitiya.	Tumpala Field.	Nikagolla Gavilipitiya Field.
	18	19	20	21	22	23	24	25
<i>Mechanical Composition.</i>								
Hygroscopic moisture and salts								
Humus	1.64	2.20	3.56	4.23	1.47	3.00	3.20	2.64
Clay	1.00	1.59	..	..	..	..	..	..
Clay	1.97	2.75	3.85	17.93	6.63	6.30	6.80	3.83
Fine silt	7.96	12.50	14.06	31.02	10.14	15.60	13.00	11.96
Fine sand	18.80	24.91	17.00	14.16	18.31	31.90	32.00	16.45
Coarse sand	23.60	25.40	30.00	23.33	30.75	24.00	19.90	32.34
Fine gravel	23.63	15.38	15.31	1.52	27.97	19.89	6.99	22.34
Coarse gravel	..	..	..	Nil	6.14	2.80	1.30	..
Water absorption	50.00	51.00	54.00	78.00	45.00	58.00	60.00	13.00
<i>Chemical Composition.</i>								
Moisture	1.000	1.200	2.600	3.340	2.480	3.300	3.100	3.000
Organic matter and combined	..	..	..	..	..	..	..	..
Oxide of iron and manganese	5.400	7.700	8.400	14.750	9.690	9.390	8.590	5.900
Oxide of alumina	8.400	7.400	8.400	13.750	10.790	9.400	8.900	8.790
Line	6.100	7.498	11.133	17.154	12.847	12.987	14.664	9.240
Potash	0.240	0.260	0.680	0.180	0.120	0.260	0.260	0.380
Soda	0.313	0.354	0.514	0.290	0.197	0.249	0.259	0.318
Sulphuric anhydride	0.262	0.551	0.731	0.500	0.318	0.459	0.330	0.166
Phosphoric acid	Nil	Nil	Nil	0.066	0.109	0.055	0.065	0.041
Chlorine	0.008	0.033	0.051	0.143	0.102	0.032	0.035	0.077
Silicic acid	82.599	76.244	68.400	49.040	63.516	63.640	63.619	75.139
Containing nitrogen	0.146	0.196	0.185	0.185	0.163	0.179	0.179	0.105
Lower oxide of iron	0.146	0.196	0.185	0.185	0.163	0.179	0.179	0.105
Reaction P. H.	7.4	Very Good	Very Good	Very Good	6.5	7.2	7.2	7.0
Humus	..	..	..	..	..	..	..	..
Chlor soluble phosphoric acid	0.034	0.038	0.034	0.006	0.006	0.007	0.006	0.006
Chlor soluble potash	..	..	..	..	..	..	..	..

Table II.

[illegible]

Table B.

Serial No.	18-20	21	22	23	24	25	26
District	Alagalla	Alagalla	Alagalla	Alagalla	Alagalla	Kurumegala	Kurumegala
Manure	1,600 lb.	1,600 ft.	1,600 ft.	1,600 ft.	1,600 ft.	400 ft.	600 ft.
Rainfall	90-8 in.	103-24 in.	90 in.	90 in.	95 in.	80 in.	80 in.
Development Area.							
Irrigation	Yes	Yes	Yes	Yes	Yes	Rain and Oya	Tank
Yield per acre, lb.	700-3,600	500	" Maha " 1,440	" Maha " 1,440	" Maha " 372	1,600 lb.	1,300 lb.
Manure	No	No	No	No	No	—	—
Broadcasted or Transplanted	Broadcasted and transplanted	Broadcasted	Broadcasted	Broadcasted	Broadcasted	Broadcasted	Broadcasted
Quantity of seed	90 lb.	90 lb.	90 lb.	90 lb.	90 lb.	90 lb.	90 lb.
Variety	Hattal and Heenati	Hondarawala	—	—	—	Hondarawala	Hondarawala

CENTRAL PROVINCE.

Alagalla-Peradeniya District.

(Tables II. and B.)

Seven samples were examined from this area. As the elevation is 1,600 feet and the rainfall 95-103 inches, with irrigation when necessary, the conditions are different to those in the low-country.

The soils are coarse gravelly loams, similar mechanically to the Hambantota soils. The coarse material averages 59 per cent., with a maximum of 72 per cent. in No. 22 and a minimum of 27 per cent. in No. 21. The silts average 35 per cent., with a maximum of 45 per cent. in No. 21 and a minimum of 18 per cent. in No. 22. Clay averages 6 per cent., with a maximum 18 per cent. in No. 21 and a minimum of 2 per cent. in No. 18. Water absorption averages 56 per cent. with a maximum of 78 per cent. in No. 21 and a minimum of 45 per cent. in No. 22.

The nitrogen averages 0.184 per cent., with a maximum of 0.235 per cent. in No. 21 and a minimum of 0.146 per cent. in No. 18. Lime has a maximum of 0.68 per cent. in No. 20 and a minimum of 0.12 per cent. in No. 22, with a mean of 0.282 per cent. Magnesia and potash are largely derived from residues of mica. The maximum of magnesia is 0.814 per cent., occurs in No. 20, the minimum 0.086 per cent. in No. 22, the mean 0.859 per cent. Potash averages 0.321 per cent., with a maximum of 0.571 per cent. in No. 20 and a minimum of 0.177 per cent. in No. 22. Available potash averages 0.023 per cent., with a maximum of 0.054 per cent. in No. 20 and a minimum of 0.006 per cent. in No. 21. Phosphoric acid is a maximum of 0.141 per cent. in No. 21 and a minimum of 0.045 per cent. in No. 18, with a mean of 0.088 per cent. The available phosphoric acid averages 0.018 per cent., with a maximum of 0.038 per cent. in No. 19 and a minimum of 0.005 per cent. in No. 21.

The method of sowing was recorded as being by broadcast at the rate of 90 lb. per acre. The yield averages 1,375 lb. per acre.

NORTH-WESTERN PROVINCE.

Kurunegala District.

Two samples were examined from this area. The elevation is 600 feet and the rainfall 80 inches, with irrigation when required, conditions are intermediate between the Southern and Central Provinces.

The area is very gravelly. Coarse material varying from 74 to 87 per cent., silt from 7 to 18 per cent., clay 4 per cent., water absorption 18 to 23 per cent.

The plant food varies as follows :—

Nitrogen 0·106 per cent. to 0·112 per cent., lime 0·240 per cent. to 0·380 per cent., magnesia 0·187 per cent. to 0·418 per cent., average 0·302 per cent., potash 0·193 per cent. to 0·232 per cent., average 0·212 per cent., available potash 0·009 per cent., phosphoric acid 0·064 per cent. to 0·077 per cent., available phosphoric acid 0·005 per cent. to 0·006 per cent. No. 25 is richer in mineral plant food and proportion of fine soil than No. 26.

Unselected seed is broadcasted at the rate of 90 lb. per acre, and a yield of 1,450 lb. per acre is produced.

No manuring is carried out.

NORTH-CENTRAL PROVINCE.

(Table III.)

[For Tables see pages 13, 14, and 15.]

Four samples were examined from the Minneriya Development Scheme and six samples from the Nachchaduwa Colonization Scheme.

Minneriya soils are coarse gravels. The coarse material averages 76 per cent., with a maximum of 86 per cent. in No. 27 and a minimum of 58 per cent. in No. 29. Silts vary from 29 per cent. in No. 29 to 9 per cent. in No. 27; average 16 per cent. Clay varies from 6 per cent. in No. 29 to 2 per cent. in Nos. 27 and 30. Water absorption averages 40 per cent., with a maximum of 48 per cent. in No. 29 and a minimum of 34 per cent. in No. 27.

Table III.

Serial No.	Coarse. Per Cent.	Silts Per Cent.	Clay. Per Cent.	Water Absorption Per Cent.	NH ₄ Per Cent.	Lime.		Magnesia		Potash.		Citric Potash.		Phos. Acid.		Yield per Acre, lb.
						Per Cent.	Cent.	Per Cent.	Cent.	Per Cent.	Cent.	Per Cent.	Cent.			
NORTH-CENTRAL PROVINCE.																
Minnetiya ..	27	86	..	9	..	0.084.	0.420.	0.418.	0.217.	0.019.	0.077.	0.077.	0.017	..	..	..
Do. ..	28	79	..	25	..	0.056.	0.420.	0.216.	0.109.	0.012.	0.102.	0.102.	0.011	..	..	..
Do. ..	29	82	..	13	..	0.045.	0.420.	0.245.	0.204.	0.017.	0.077.	0.077.	0.010	..	..	..
Do. ..	30	82	..	13	..	0.045.	0.400.	0.245.	0.204.	0.017.	0.077.	0.077.	0.010	..	..	..
Average ..	—	76	..	16	..	0.065.	0.445.	0.309.	0.190.	0.016.	0.089.	0.089.	0.015	..	..	..
Nachachadwa ..	31	97	..	23	..	0.112.	0.460.	0.245.	0.139.	0.009.	0.074.	0.074.	0.008	..	..	..
Do. ..	32	88	..	23	..	0.067.	0.460.	0.245.	0.139.	0.009.	0.074.	0.074.	0.008	..	..	..
Do. ..	33	65	..	23	..	0.067.	0.460.	0.245.	0.139.	0.009.	0.074.	0.074.	0.008	..	..	..
Do. ..	34	75	..	17	..	0.112.	0.480.	0.302.	0.093.	0.011.	0.102.	0.102.	0.012	..	..	..
Do. ..	35	77	..	22	..	0.106.	0.500.	0.216.	0.237.	0.013.	0.079.	0.079.	0.009	..	..	..
Do. ..	36	77	..	22	..	0.106.	0.500.	0.216.	0.237.	0.013.	0.079.	0.079.	0.009	..	..	..
Average ..	—	70	..	19	..	0.100.	0.520.	0.393.	0.152.	0.015.	0.083.	0.083.	0.009	..	..	..
NORTHERN PROVINCE.																
Karachchi ..	37	80	..	12	..	0.073.	0.240.	0.216.	0.154.	0.005.	0.079.	0.079.	0.008	..	..	..
Do. ..	38	81	..	11	..	0.073.	0.240.	0.202.	0.193.	0.007.	0.004.	0.004.	0.005	..	..	..
Do. ..	39	85	..	9	..	0.067.	0.160.	0.086.	0.120.	0.006.	0.060.	0.060.	0.006	..	..	..
Do. ..	40	86	..	7	..	0.065.	0.200.	0.115.	0.162.	0.006.	0.077.	0.077.	0.005	..	..	..
Do. ..	41	81	..	7	..	0.065.	0.200.	0.115.	0.162.	0.006.	0.077.	0.077.	0.005	..	..	..
Do. ..	42	86	..	8	..	0.060.	0.180.	0.173.	0.124.	0.005.	0.064.	0.064.	0.006	..	..	..
Do. ..	43	82	..	9	..	0.112.	0.260.	0.187.	0.175.	0.010.	0.051.	0.051.	0.006	..	..	..
Do. ..	44	84	..	7	..	0.112.	0.260.	0.187.	0.175.	0.010.	0.051.	0.051.	0.006	..	..	..
Do. ..	45	83	..	4	..	0.106.	0.140.	0.116.	0.162.	0.006.	0.077.	0.077.	0.008	..	..	..
Do. ..	46	75	..	14	..	0.084.	0.290.	0.144.	0.225.	0.008.	0.064.	0.064.	0.008	..	..	..
Average ..	—	83	..	7	..	0.080.	0.216.	0.160.	0.163.	0.007.	0.067.	0.067.	0.008	..	..	..

Nitrogen is generally poor in these soils. A maximum of 0.157 per cent. in No. 29 and a minimum of 0.045 per cent. in No. 30, average 0.085 per cent. Lime averages 0.445 per cent., with a maximum of 0.540 per cent. in No. 29 and a minimum of 0.400 per cent. in No. 30. Magnesia varies from 0.216 per cent. in No. 28 to 0.418 per cent. in No. 27; average 0.309 per cent. Potash averages 0.190 per cent., with a maximum of 0.231 per cent. in No. 29 and a minimum of 0.109 per cent. in No. 28. Available potash averages 0.016 per cent., with a maximum of 0.019 per cent. in No. 27 and a minimum of 0.012 per cent. in No. 28. Phosphoric acid averages 0.089 per cent., with a maximum of 0.102 per cent. in Nos. 28 and 29, and a minimum of 0.077 per cent. in Nos. 27 and 30. Available phosphoric acid has a maximum of 0.019 per cent. in No. 30, and a minimum of 0.011 per cent. in No. 28; average 0.015 per cent.

The proportion of fine soil is small, but the mineral plant food is in good supply.

The soils are slightly alkaline.

Rainfall 65 inches.

No yields or other particulars are available as this is a development area.

Nachchaduwa.—Soils from this area are coarse gravels resembling the Minneriya soils mechanically and chemically. A feature of these soils would be their inability to hold large proportions of irrigation water if applied; this will improve on cultivation.

Coarse gravel varies from 75 per cent. in No. 34 to 65 per cent. in No. 33; average 70 per cent. Silts average 19 per cent., with a maximum of 23 per cent. in Nos. 31 and 33 and a minimum of 16 per cent. in No. 36. Clay averages 4 per cent., with a maximum of 5 per cent. in No. 33 and a minimum of 3 per cent. in Nos. 35 and 36. Water absorption averages 41 per cent., with a maximum of 44 per cent. in Nos. 31, 35, and 36 and a minimum of 32 per cent. in No. 32.

Nitrogen averages 0.10 per cent., with a maximum of 0.112 per cent. in Nos. 31 and 34 and a minimum of 0.067 per cent. in No. 33. Lime is in fair supply throughout, which gives the soils an alkaline reaction. The maximum is 0.660 per cent. in No. 33 and the minimum 0.420 per cent. in No. 36; average 0.5 per cent. Magnesia averages 0.393 per cent., with a maximum of 0.749 per cent. in No. 33 and a minimum of 0.216 per cent. in No. 35. Potash averages 0.152 per cent., with a maximum of 0.201 per cent. in Nos. 33

and 36 and a minimum of 0·093 per cent. in No. 34. Available potash averages 0·0105 per cent., with a maximum of 0·013 per cent. in Nos. 33 and 36 and a minimum of 0·008 per cent. in No. 32. Phosphoric acid varies from 0·102 per cent. in Nos. 33 and 34 to 0·064 per cent. in No. 31; average 0·083 per cent. Available phosphoric acid averages 0·009 per cent., with a maximum of 0·012 per cent. in No. 34 and a minimum of 0·008 per cent. in Nos. 31 and 32.

The proportion of fine soil is poor, and the retention of water is poor. The fine soil has a good supply of mineral plant food. Reaction alkaline.

Pioneer area; no details of yield, &c.

Rainfall 65 inches.

NORTHERN PROVINCE.

Karachchi.—This is a pioneer area; no details are available as to yield, &c.

The soils are coarse gravels, with only a small proportion of fine soil. The plant food generally is rather poor. The soils are alkaline. The retention of water is poor.

Coarse material averages 83 per cent., varying from 75 per cent. in No. 46 to 89 per cent. in No. 40. Silts vary from 2 per cent. in No. 40 to 12 per cent. in No. 37, averages 7 per cent. Clay varies 1 per cent. in No. 39 to 14 per cent. in No. 46, averages 7 per cent. Water absorption averages 31 per cent., varying from 29 per cent. in No. 40 to 34 per cent. in Nos. 44 and 46.

Nitrogen varies from 0·067 per cent. in No. 39 to 0·112 per cent. in Nos. 43 and 44; average 0·09 per cent. Lime averages 0·216 per cent., and varies from 0·26 per cent. in Nos. 44 and 46 to 0·14 per cent. in No. 45. Magnesia averages 0·15 per cent., and has a maximum of 0·216 per cent. in No. 37 and a minimum of 0·086 per cent. in No. 40. Potash varies from 0·225 per cent. in No. 46 to 0·12 per cent. in No. 40, average 0·163 per cent. Available potash averages 0·007 per cent., and has a maximum of 0·01 per cent. in No. 44 and a minimum of 0·005 per cent. in Nos. 37 and 42. Available phosphoric acid averages 0·006 per cent., and varies from 0·005 to 0·006 per cent. Total phosphoric acid averages 0·069 per cent., with a maximum of 0·090 per cent. in No. 40 and a minimum of 0·051 per cent. in Nos. 43 and 44.

Eastern Province.

Trincanale District.		Batticaloa District.								
Serial No.	47	Allal Extension Scheme.		Koddar Pattu Vaddichal- chenal Field.		Matupala Kudam.	Buffalo Island.	Mawadikudam at Ilund- chenal Kudam.		Kavadi Kudam.
		48	49	50	51			52	53	
<i>Mineral Composition.</i>										
		No. 1	No. 2	No. 3						
Hygroscopic moisture and salts dissolved...		8.50	8.44	2.81	3.70	1.60	2.60	3.30	5.20	
Humus ..		1.23	1.12	0.77	2.05	0.90	1.70	2.00	3.60	
Clay ..		13.79	18.37	15.80	10.93	3.80	7.40	6.20	49.10	
Slit all ..		6.15	6.70	4.47	6.40	3.50	5.70	6.70	40.40	
Fine sand ..		37.63	10.62	15.04	32.53	11.60	11.30	25.60	13.40	
Coarse sand ..		26.95	26.25	34.30	16.50	46.70	54.40	37.00	6.00	
Gravel ..		2.14	2.14	2.14	2.14	31.70	31.70	31.70	31.70	
Water absorption ..		42.00	36.00	36.00	44.00	34.00	34.00	43.00	70.0	
<i>Chemical Composition.</i>										
Moisture		1.600	2.800	2.200	5.000	1.800	1.200	3.000	3.700	
Organic matter and combined water		5.400	7.500	6.600	5.600	3.100	5.200	4.400	9.900	
Oxide of iron and manganese		3.440	5.280	5.360	5.760	5.600	6.600	8.600	7.200	
Oxide of alumina		0.740	0.440	0.540	0.520	0.580	0.340	0.540	1.000	
Magnesia ..		0.245	0.432	0.220	0.662	0.749	0.583	0.647	0.860	
Potash ..		0.184	0.270	0.100	0.490	0.502	0.580	0.753	0.576	
Soda ..		0.012	0.069	0.027	0.063	0.045	0.106	0.083	0.124	
Silicic anhydride		0.068	0.077	0.051	0.090	0.077	0.077	0.092	0.124	
Phosphoric acid		0.016	0.015	0.010	0.031	0.021	0.021	0.021	0.021	
Chlorine ..		0.129	0.129	0.129	0.129	0.129	0.129	0.129	0.129	
Sulphur ..		0.129	0.129	0.129	0.129	0.129	0.129	0.129	0.129	
Equal to ammonia		0.129	0.129	0.129	0.129	0.129	0.129	0.129	0.129	
Lower oxide of iron		Good	Good	Good	Good	Good	Good	Good	Good	
Reaction F. B.		Little	Little	Little	Little	Little	Little	Little	Little	
Chlor soluble phosphoric acid		0.028	0.015	0.0086	0.008	0.0077	0.005	0.008	0.005	
Chlor soluble potash		0.024	0.039	0.016	0.007	0.016	0.008	0.008	0.012	

EASTERN PROVINCE.

Trincomalee District.

(Tables IV. and C.)

Allai Extension.—Three soils were examined from this area. As this is a pioneer proposition, no details of crops are available.

Batticaloa.—Four samples were examined from this district from fields in cultivation.

The soils from the Eastern Province taken as a whole are coarse gravels. The coarse material averages 64 per cent., and varies from 90 per cent. in No. 51 to 9 per cent. in No. 54; by eliminating No. 54, which is rather a different type from the others, an average of 71 per cent. coarse material is obtained. Similarly, with the silts, the average is 17 per cent., with a maximum of 25 per cent. in No. 48 and a minimum of 6 per cent. in No. 51. Clay averages 9 per cent., and varies from 20 per cent. in No. 54 to 2 per cent. in No. 51. Water retentive power varies from 34 per cent. in Nos. 51 and 52 to 70 per cent. in No. 54; by eliminating No. 54, the maximum is found in No. 53 with 48 per cent., and the average then works out at 39 per cent.

The nitrogen is poor, averaging 0.098 per cent., with a maximum of 0.168 per cent. in No. 48 and a minimum of 0.039 per cent. in No. 52. Lime is in good supply, and averages 0.497 per cent. The maximum is found in No. 47 with 0.74 per cent., the minimum in No. 52 with 0.34 per cent. Magnesia varies from 0.749 per cent. in No. 51 to 0.220 per cent. in No. 49; average 0.495 per cent. Potash averages 0.417 per cent., with a maximum of 0.753 per cent. in No. 54 and a minimum of 0.100 per cent. in No. 49. Available potash averages 0.016, and varies from 0.039 per cent. in No. 48 to 0.007 per cent. in No. 50. Phosphoric acid averages 0.078 per cent., and varies from 0.09 per cent. in Nos. 50 and 54 to 0.051 per cent. in No. 49. Available phosphoric acid averages 0.011 per cent., and varies from 0.005 per cent. in Nos. 52 and 54 to 0.015 per cent. in No. 48.

The soils from this area are more or less slightly alkaline, in particular those from Trincomalee District.

Unselected seed is used, sown at the rate of 90–170 lb. per acre by broadcasting and yielding up to 990 lb. per acre, average 830 lb. per acre, without intensive cultivation.

Table V.

[illegible]

* Deleted for average.

GENERAL REMARKS ON CEYLON PADDY SOILS.

(Table V.)

The Ceylon paddy soils which have been examined are coarse gravelly loams, with the exception of those obtained from Matara, which have less coarse material than the other areas considered, and have more silts, clay, and organic matter. Eliminating the Matara area, the "coarse" averages for the Island, 71 per cent., silts 18 per cent., clay 6 per cent., water retentive power 41 per cent.; this gives a free draining soil mass, but with a small water-holding power and a poor feeding surface.* The fine soil is not rich in nitrogen, averaging 0.122 per cent., it is poorest in the North-Central Province, (Minneriya), 0.085 per cent., and richest in the Western Province, 0.342 per cent., that is eliminating the exceptional Matara soils, which are exceedingly rich in organic matter and nitrogen (nitrogen 0.579 per cent.). The lime percentage obtained is high for Ceylon, averaging 0.392 per cent.† Lime is highest in the Southern Province (Hambantota), 0.938 per cent.; and lowest in the Western Province, 0.140 per cent. In the Matara District of the Southern Province, lime is 0.195 per cent., due to acidity developed by the excessive organic matter having dissolved out the lime. Compare neighbouring district Hambantota. Magnesia averages 0.362 per cent., and is low, as with the lime, in the Southern Province (Matara), 0.110 per cent., for above reason; the lowest is in the Western Province 0.087 per cent. Potash averages 0.260 per cent. being lowest in the North-Central Province (Nachchaduwa) 0.152 per cent., and highest in the Southern Province (Hambantota) 0.450 per cent. Available potash averages 0.014 per cent., is highest in the Central Province 0.023 per cent., and lowest in the Northern Province (Karachchi) 0.007 per cent. Phosphoric acid averages 0.101 per cent., and is richest in the Southern Province (Hambantota) 0.178 per cent., and lowest in the Northern Province (Karachchi) 0.069 per cent. Available phosphoric acid averages 0.0115 per cent., is lowest in the North-Western Province 0.005 per cent., and highest in the Central Province 0.018 per cent.

* Excluding Matara and the pioneer areas, "coarse" amounts to 63 per cent., silts 24 per cent., clay 7 per cent., water absorption 48 per cent., nitrogen 0.184 per cent.

† If Hambantota and pioneer areas are deleted, lime averages 0.285 per cent.

The reactions of the soils are mostly alkaline or practically neutral. The soils examined from the Matara District are, however, exceptions to this, the soils there being acid, developed from the excessive organic matter present.

Elevation varies from sea level to 1,600 feet where the samples were taken, and the rainfall varies from 38 inches to 150 inches. Irrigation is also given when required.

Unselected seed is generally sown broadcast at the rate of from 90 lb. to 168 lb. per acre, and yields on an average 1,060 lb. paddy per acre.

Manuring is carried out on some of the areas, which has raised the average yield.

INDIAN SOILS.

[For Tables see pages 24 and 25.]

Ten samples of soil were examined from South India, of which 5 were surface soils and 5 corresponding sub-soils. The soils were obtained from Coimbatore, Tanjore, Trichinopoly, and Tinnevely Districts.

Nearly half the weight of the soil is coarse material, 52 per cent. Of the several districts, Coimbatore and Tinnevely have least coarse material, 44 per cent. and 46 per cent. respectively, while Trichinopoly the most, 67 per cent. Silts average 29 per cent. Tinnevely and Coimbatore have most silts, 35 and 34 per cent. respectively. Clay does not predominate in any of the soils, the average is 10 per cent. Coimbatore has most at 15 per cent. and Trichinopoly least at 7 per cent. These figures refer to the surface soils only, for comparison with surface soils examined in Ceylon.

Water retentive power averages 51 per cent., is highest in the Coimbatore District (58 per cent.), and lowest in the Tanjore and Tinnevely Districts (46 per cent.). The Trichinopoly sub-soil has a low retentive power for water, 32 per cent., due to the large proportion of coarse material (88 per cent.), and the low proportion of silts (5 per cent.) and clay (3 per cent.); this very porous sub-soil would influence the drainage and retention of water in the surface soil.

Table VI.

SOUTH INDIA.																					
Serial No.	Coarse.	Silt.	Water		Clay		Nitrogen.		Lime.		Magnesia.		Potash.		Citric.		Phos. Acid.	Yield Per Acre. lb.			
			Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.							
Coimbatore District.																					
Central Farm ..	1	44	33	52	15	52	0.086	0.940	1.325	0.942	0.019	0.154	0.021	2,600	..	..	..	2,600
Pachhal Gavi ..	2	51	17	22	54	54	0.048	0.840	0.478	0.787	0.014	0.154	0.012	3,700	..	..	..	3,700
Chethipallam Taluk ..	3	43	34	34	10	48	0.174	2.860	1.253	0.775	0.033	0.230	0.023	1,800-2,000	..	..	..	1,800-2,000
Tanjore District.																					
Tiruvadi Taluk ..	5	60	24	9	46	46	0.084	0.880	0.648	0.408	0.018	0.180	0.015	..	..	..	..	..
Vysa Rao of Kum- bakonam ..	6	62	22	9	46	46	0.045	0.920	0.662	0.354	0.018	0.154	0.015	..	..	..	..	..
Tinnevely District.																					
Aganapuram ..	7	87	18	7	56	56	0.078	1.760	1.008	0.490	0.021	0.180	0.017	..	..	..	..	..
Karur Taluk ..	8	88	5	32	32	32	0.022	1.740	0.749	0.313	0.011	0.154	0.012	..	..	..	..	..
Tampara District.	9	46	35	11	46	46	0.045	0.580	0.302	0.618	0.018	0.154	0.015	2,500-3,000	..	..	..	2,500-3,000
Tampara Taluk ..	10	52	33	9	49	49	0.073	0.600	0.374	0.810	0.023	0.192	0.023	2,700	..	..	..	2,700
Average ..	—	52	29	10	51	51	0.087	1.304	0.907	0.647	0.022	0.176	0.018	..	..	..	..	..
Table D.																					
Serial No.	1-2.	Coimbatore	3-4.	Coimbatore	5-6.	Tanjore	7-8.	Tinnevely	9-10.												
											
Dist. Co.	1,300 ft.	1,300 ft.	1,300 ft.	1,300 ft.	1,300 ft.	1,300 ft.	1,300 ft.	1,300 ft.	1,300 ft.												
Elevation	22 ft.	22 ft.	22 ft.	22 ft.	22 ft.	22 ft.	22 ft.	22 ft.	22 ft.												
Rainfall	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes												
Irrigation	Grain, 3,700 lb.	Grain, 3,700 lb.	Grain, 3,700 lb.	Grain, 3,700 lb.	Grain, 3,700 lb.	Grain, 3,700 lb.	Grain, 3,700 lb.	Grain, 3,700 lb.	Grain, 3,700 lb.												
Yield per acre	Grain, 2,615 lb.	Grain, 2,615 lb.	Grain, 2,615 lb.	Grain, 2,615 lb.	Grain, 2,615 lb.	Grain, 2,615 lb.	Grain, 2,615 lb.	Grain, 2,615 lb.	Grain, 2,615 lb.												
Manures	Straw, 5,565 lb.	Straw, 5,565 lb.	Straw, 5,565 lb.	Straw, 5,565 lb.	Straw, 5,565 lb.	Straw, 5,565 lb.	Straw, 5,565 lb.	Straw, 5,565 lb.	Straw, 5,565 lb.												
Broadcasted or Transplanted	Transplanted	Transplanted	Transplanted	Transplanted	Transplanted	Transplanted	Transplanted	Transplanted	Transplanted												
											
Quantity of seed	21 lb. sown in 8 cents	21 lb. sown in 8 cents	21 lb. sown in 8 cents	21 lb. sown in 8 cents	21 lb. sown in 8 cents	21 lb. sown in 8 cents	21 lb. sown in 8 cents	21 lb. sown in 8 cents	21 lb. sown in 8 cents												
Variety	Poomballi, Sadal, Samba, Kar, Sadal Samba, Ayan Samba, and Anal Chatta	Poomballi, Sadal, Samba, Kar, Sadal Samba, Ayan Samba, and Anal Chatta	Poomballi, Sadal, Samba, Kar, Sadal Samba, Ayan Samba, and Anal Chatta	Poomballi, Sadal, Samba, Kar, Sadal Samba, Ayan Samba, and Anal Chatta	Poomballi, Sadal, Samba, Kar, Sadal Samba, Ayan Samba, and Anal Chatta	Poomballi, Sadal, Samba, Kar, Sadal Samba, Ayan Samba, and Anal Chatta	Poomballi, Sadal, Samba, Kar, Sadal Samba, Ayan Samba, and Anal Chatta	Poomballi, Sadal, Samba, Kar, Sadal Samba, Ayan Samba, and Anal Chatta	Poomballi, Sadal, Samba, Kar, Sadal Samba, Ayan Samba, and Anal Chatta												

Nitrogens are poor, average 0·087 per cent. Coimbatore contains the highest percentage 0·174 per cent. and Tinnevely the lowest 0·045 per cent. The lime is high, average 1·304 per cent. Coimbatore is highest 2·360 per cent. Tinnevely lowest 0·580 per cent. Magnesia follows the same order as the lime, averages 0·907 per cent., is highest at Coimbatore 1·325 per cent., lowest at Tinnevely 0·302 per cent. Potash averages 0·647 per cent., is highest at Coimbatore 0·942 per cent., lowest at Tanjore 0·408 per cent. Available potash averages 0·022 per cent. Coimbatore has most 0·033 per cent., Tanjore and Tinnevely the least 0·018 per cent. Phosphoric acid averages 0·176 per cent., is highest in the Coimbatore District 0·230 per cent., lowest in the Tinnevely District 0·154 per cent. Available phosphoric acid averages 0·018 per cent., is highest at Coimbatore 0·023 per cent., and lowest at Tanjore and Tinnevely 0·015 per cent.

The reaction is alkaline in all the districts, due to the presence of large proportions of alkaline earths, lime and magnesia. P. H. 7·8 to 8·7.

Elevation varies from 20 feet to 1,200 feet, and rainfall from 20 inches to 45 inches ; irrigation is applied as required.

Seed used is mostly selected ; 75 to 90 lb. per acre are sown in a nursery and then transplanted in the field. Crops vary from 1,800 lb. per acre per crop to 3,700 lb. per acre per crop. Sometimes two crops are taken during the year. Average yield is 2,700 lb.

Cultivation is confined to the usual ploughing and manure applied in the form of green manure, cattle manure, and sometimes oil cake.

BURMA SOILS.

[For Tables see pages 27, 28, 29, and 30.]

Twenty-four samples of soil were examined from Burma, obtained from Pegu, Toungoo, Minbu, Tharrawaddy, and Prome Districts. Each surface sample taken to a depth of 6 inches had the corresponding 2nd, 3rd, and 4th, six inches examined. The surface soil analyses only are comparable to the Ceylon analyses as the latter are obtained from surface soils.

Burma Boils.

[illegible]

Table VII.

Serial No.	Coarse.	Silt.	Clay.	Water.	Nitro.	Lime.	Magnesia.	Potash.	Glauc. Phosphate.		Citric.	Yield per Acre.	
									Per Cent.	Per Cent.			Per Cent.
BURMA.													
Pegu District.													
Nyaungabin													
1	9	58	23	71	0.134	0.440	1.210	0.903	0.014	0.295	0.013	2,000	
2	8	52	20	67	0.108	0.380	0.426	1.150	0.014	0.154	0.010	—	
3	8	52	20	67	0.101	0.540	1.282	1.089	0.016	0.179	0.007	—	
4	18	58	26	66	0.145	0.380	0.734	1.042	0.014	0.230	0.017	2,000	
5	17	48	29	67	0.128	0.380	0.945	1.127	0.015	0.259	0.015	—	
6	8	62	28	74	0.123	0.420	0.783	1.065	0.014	0.179	0.018	—	
7	8	60	28	74	0.123	0.420	0.783	1.065	0.014	0.179	0.018	—	
8	14	42	32	76	0.112	0.500	1.063	1.028	0.015	0.179	0.005	—	
Toungoo District.													
Pylamana													
9	17	65	10	67	0.134	0.610	0.461	0.979	0.015	0.154	0.021	2,000	
10	17	66	8	68	0.106	0.660	0.380	0.463	0.015	0.179	0.019	—	
11	17	66	8	68	0.095	0.720	1.066	0.741	0.011	0.205	0.012	—	
12	13	67	10	68	0.089	0.690	1.080	0.795	0.008	0.179	0.009	—	
Minbu District.													
Pwabinu													
13	14	69	11	68	0.120	0.660	0.682	1.050	0.015	0.179	0.015	2,500	
14	13	63	17	65	0.118	0.820	1.267	0.950	0.016	0.205	0.016	—	
15	13	63	17	65	0.118	0.820	1.267	0.950	0.016	0.205	0.016	—	
16	13	63	17	65	0.118	0.820	1.267	0.950	0.016	0.205	0.016	—	
Tharawaddy District.													
Zigon													
17	16	60	18	68	0.106	0.680	1.831	0.718	0.025	0.205	0.015	2,000	
18	32	50	12	64	0.080	0.700	1.224	0.772	0.017	0.192	0.010	—	
19	32	50	12	64	0.080	0.700	1.224	0.772	0.017	0.192	0.010	—	
20	10	58	24	67	0.106	0.680	1.670	1.119	0.026	0.166	0.010	—	

Table VII.—*contd.*

Prome District.	Serial No.	Coarse.	Silt.	Clay.	Absorption.	Water	Nitro-	Lime.	Magnesia.	Potash.	Citric	Phos.	Acid.	Yield per Acre.
		Per	Per	Per	Per	Per	Per	Per	Per	Per	Per	Per	Per	lb.
		Cent.	Cent.	Cent.	Cent.	Cent.	Cent.	Cent.	Cent.	Cent.	Cent.	Cent.	Cent.	
Faungde	21	3	55	34	66	0.112	0.400	1.387	1.181	0.018	0.205	0.009	0.009	2,000
	22	6	56	32	66	0.101	0.520	1.282	1.065	0.016	0.154	0.009	0.009	—
	23	9	56	33	67	0.128	0.460	1.299	1.119	0.021	0.153	0.006	0.006	—
	24	8	56	33	67	0.128	0.460	1.299	1.119	0.021	0.153	0.006	0.006	—
	25	13	58	21	65	0.126	0.527	1.083	0.939	0.017	0.153	0.010	0.010	2,000
Average 1st 6 inches	—	8	56	25	68	0.115	0.490	1.283	1.040	0.013	0.178	0.013	0.013	2,000
	Pegu No. 1	17	46	20	71	0.127	0.415	0.832	1.065	0.014	0.217	0.015	0.015	2,000
	Toungoo	12	46	18	68	0.121	0.415	0.832	1.065	0.014	0.217	0.015	0.015	2,000
	Minbyu	14	65	16	58	0.121	0.740	1.027	1.065	0.012	0.178	0.017	0.017	2,000
	Tharawaddy	24	63	16	63	0.098	0.770	1.400	0.863	0.022	0.188	0.007	0.007	2,000
Prome	—	13	58	33	67	0.108	0.475	1.339	1.130	0.017	0.188	0.012	0.012	2,000
Average	—	13	58	21	66	0.113	0.601	1.117	0.983	0.015	0.188	0.012	0.012	2,000

Table E.

Serial No.	1-4	5-8	9-12	13-16	17-20	21-24
District	Pegu	Pegu	Toungoo	Minbyu	Tharawaddy	Prome
Elevation	100 ft.	100 ft.	260 ft.	300 ft.	150 ft.	50 ft.
Irrigation	80 lb.	80 lb.	60 in.	40 in.	70 in.	70 in.
Manure	2,000 lb.	No	No	No	No	No
Broadcasted or Transplanted	Nursery received cattle manure	Nursery received cattle manure	Nursery received cattle manure	Nursery received cattle manure	2,000 lb. Sterile manure	2,000 lb. Sterile manure
Quantity of seed	40-50 lb.	40-50 lb.	40-50 lb.	Transplanted	Transplanted	Transplanted
Variety	Long and medium	Long and medium	Long	Long	Medium	Medium

The Burma paddy growing districts lie in the areas watered by the Irrawaddy-Sittaung-Salvin rivers and their numerous tributaries. The soils are silts derived from these rivers.

Pegu District.

Nyaunglebin-Daiku.—The soil from this area are clayey silts, with 9 to 17 per cent. coarse matter. The clay varies from 23 to 29 per cent. Silts which form the greater proportion of the soil fractions, 58 to 43 per cent. Water retention 71 to 67 per cent. is high due to the high proportion of silts and clay present.

There is a fair supply of nitrogen. The mineral plant food is in reserve, the potash in particular. The soils are alkaline, P. H. 8·2.

Yield is about 2,000 lb. per acre, obtained by sowing ordinary seed (long and medium) at the rate of 400 to 500 lb. per acre in a nursery, manuring with cattle manure and transplanting in the field. No manuring takes place in the field. Rotation of crops is not practised.

Elevation 100 feet. Rainfall 80 inches. No irrigation is given.

Toungoo District.

Pyinmana.—The soils from this area are less clayey and more gravelly than those from the Pegu District. Coarse material amounts to 17 per cent. Silt to 65 per cent., clay 10 per cent. Water retention 67 per cent., a little lower than the Pegu area.

Nitrogen on an average is less than the Pegu area. The mineral plant food is in good reserve, but in less supply than the Pegu District. The soils are alkaline, P. H. 8·3.

Elevation is 230 feet. Rainfall 60 inches. Irrigation 20 inches is given. Toungoo District is situated in the intermediate zone. Pegu district in the wet zone.

Long ordinary variety of seed is sown as above.

BURMA.

Minbyu District.

Pwinbyu.—The soils from this area are more clayey than Toungoo District and less clayey than Pegu District. Coarse material amounts to 14 per cent., silt 65 per cent., and clay 15 per cent. Water retention, 58 per cent., is less than above.

Nitrogen on an average is the same as Pegu and more than Toungoo. The mineral plant food is in good reserve, potash in particular. Soils are alkaline P. H. 8·2.

Rainfall 40 inches; elevation 300 feet. Minbyu District falls in the dry zone. Irrigation 40 inches is given.

Unselected long variety of seed is sown as above. Yield 2,500 lb. per acre, which is 500 lb. heavier than the other districts considered.

Tharrawaddy District.

Zigon.—In this district clay amounts to 18 per cent., silts 60 per cent., coarse material 16 per cent., water retention 58 per cent.

The nitrogen is lower in this district than the others. The mineral plant food is in reserve, magnesia in particular, which is higher than the other districts. The soils are alkaline P. H. 8·4.

Rainfall 70 inches; elevation 150 feet. Wet zone.

Yield 2,000 lb. per acre. Sowing as above. Medium variety used.

Prome District.

Paungde.—This area is clayey compared with the other districts, and contains less coarse material. Clay amounts to 34 per cent., silt to 55 per cent., coarse matter 3 per cent., retention of water 66 per cent.

The nitrogen is low. The mineral plant food is in reserve, in particular magnesia and potash. The soils are alkaline. P. H. 8·3.

Rainfall 70 inches; elevation 150 feet. Wet zone.

Average nitrogen is 0·113 per cent. This is exceeded in the Pegu District 0·121 per cent., Minbyu 0·121 per cent., and below in the other districts, Toungoo 0·106 per cent., Tharrawaddy 0·098 per cent., Prome 0·108 per cent. Lime averages 0·601 per cent. This is exceeded in Toungoo 0·675 per cent., Minbyu 0·780 per cent., Tharrawaddy 0·770 per cent., and below the average in Pegu 0·452 per cent., Prome 0·475 per cent. Magnesia is highest in the Tharrawaddy District 1·4 per cent., next in Prome 1·339 per cent., Pegu No. 1, 1·289 per cent., Minbyu 1·051 per cent., below the average at Toungoo 0·742 per cent., Pegu No. 2, 0·882 per cent., Average magnesia 1·117 per cent. Potash is richest in Prome 1·13

per cent., next Pegu No. 1, 1.04 per cent., No. 2, 1.065 per cent., Minbyu 1.01 per cent., below the average in Toungoo 0.669 per cent., Tharrawaddy 0.863 per cent. Average potash 0.963 per cent. Available potash averages 0.015 per cent., richest in Tharrawaddy 0.022 per cent., Prome 0.017 per cent., lowest in Toungoo 0.022 per cent., Pegu No. 1, 0.013 per cent., No. 2, 0.014 per cent. Phosphoric acid averages 0.188 per cent., is highest in Pegu No. 2, 0.217 per cent., Minbyu 0.205 per cent., lowest in Prome 0.166 per cent., Pegu No. 1 0.173 per cent. Available phosphoric acid averages 0.012 per cent., is lowest, in Prome 0.007 per cent., Pegu No. 1 0.010 per cent., Tharrawaddy 0.011 per cent., richest in Minbyu 0.017 per cent., Toungoo 0.015 per cent., which are above the average.

GENERAL OBSERVATIONS ON THE BURMA PADDY SOILS.

The main feature of the Burma paddy soils is the high proportion of silt fractions and the high water retention. The soils are alkaline P. H. 8.4. The mineral plant food is in good reserve, the magnesia and potash being particularly rich. The nitrogen is poor. There is only a small difference in the average analyses of the surface soils and the average of the surface and sub-soils.

Elevation varies from 100 feet in the Pegu District (Nyaunglebin and Daiku)—to 300 feet in the Minbyu District (Pwinbyu). Rainfall varies from 40 inches in the Minbyu District (Pwinbyu) to 80 inches in the Pegu District (Nyaunglebin—Daiku). Irrigation is given in the Toungoo District (Pyinmana) up to 20 inches to make up the total precipitation to 80 inches. Minbyu District receives 40 inches of irrigation to make up for the low rainfall of 40 inches.

Seed is sown in the nursery at the rate of 400–500 lb. per acre, manured with cattle manure, and transplanted to the fields. The fields are prepared by ploughing and repeated harrowing. No manuring takes place in the fields. The same procedure takes place in all the districts; ordinary seed is sown in the nursery. If the period in which water is available is long, then long-lived variety giving high yields is grown; if the period is short, during which water is available, a paddy with a medium life period giving little less yield is used. In the Pegu and Toungoo Districts long and medium varieties are cultivated. In the Minbyu District the long variety is used. In the Tharrawaddy and Prome districts the medium variety. No rotation of crops is practised.

Federated Malay States and Straits Settlements.

	Kuala Lipis.			Tanjung Besar.	Sega.	Kuantan.			Kuala Pila.			Malacca Central.		
	Pengon.	Budu.				Dong.	Gall.	Mukim Ulu Muar.	Mukim Sri Monda.	Mukim Semabok.				
	1	2	3	4	5	6	7	8	9					
<i>Mechanical Composition.</i>														
Hygroscopic moisture and salts dissolved	6.30	2.00	1.40	2.00	3.60	8.20	2.60	1.50	3.10					
Humus	4.50	2.00	1.00	1.90	3.60	3.00	1.80	1.00	1.70					
Clay	24.00	18.80	15.90	18.20	10.40	12.50	12.80	8.00	10.20					
Fine silt	42.50	35.70	35.70	35.70	35.70	35.70	35.70	35.70	35.70					
Silt	18.80	18.80	18.80	18.80	18.80	18.80	18.80	18.80	18.80					
Fine sand	17.40	17.40	17.40	17.40	17.40	17.40	17.40	17.40	17.40					
Coarse sand	6.80	35.70	26.50	33.60	33.60	33.60	33.60	33.60	33.60					
Gravel	0.70	19.90	6.20	9.80	6.00	3.00	0.80	0.70	0.10					
Water absorption	0.70	2.20	2.20	3.50	NH	6.30	0.50	23.50	0.10					
	NH	0.5	NH	NH	NH	NH	NH	NH	NH					
	82.00	60.00	32.00	56.00	32.00	60.00	78.00	55.00	62.00					
<i>Chemical Composition.</i>														
Moisture	2.00	1.80	0.80	1.40	1.00	0.60	1.00	0.60	1.60					
Organic matter and combined water	23.00	4.80	0.00	5.40	0.80	5.20	0.60	0.80	4.70					
Oxide of iron and manganese	3.50	3.80	3.80	3.20	2.40	2.40	2.00	1.30	1.60					
Lime	0.250	0.360	0.320	0.160	0.240	0.310	0.240	0.100	0.200					
Magnesia	0.130	0.288	0.259	0.130	0.058	0.072	0.134	0.101	0.148					
Soda ash	0.471	0.193	0.201	0.178	0.167	0.309	0.309	0.208	0.424					
Sulphuric anhydride	0.063	0.032	0.036	0.036	0.035	0.259	0.045	0.022	0.065					
Phosphoric acid	0.115	0.102	0.115	0.077	0.077	0.077	0.077	0.077	0.102					
Chlorine	0.045	0.014	0.018	0.016	0.021	0.018	0.017	0.018	0.025					
Sulphates	62.900	78.740	79.260	84.340	80.010	84.340	70.340	79.660	80.250					
Equal to ammonia	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130					
Lower oxide of iron	0.864	0.122	0.150	0.184	0.156	0.129	0.122	0.139	0.143					
Reaction P. H.	Much	Much	Little	Much	Fair	Little	Trace	Little	Little					
Humus	5.1	7.2	6.1	6.8	6.7	4.9	5.5	5.2	4.8					
	Good	Little	Fairly	Fairly	Little	Little	Little	Little	Good					
Citric acid soluble phosphoric acid	0.006	0.004	0.010	0.009	0.005	0.005	0.004	0.003	0.004					
Citric acid soluble potash	0.0066	0.006	0.0062	0.006	0.0085	0.009	0.0073	0.0086	0.0066					

Malacca Central.	Krian District.										Titl Serong.	Metang Fear.
	Sumpang Ampat.	Tanpong Pundang.	Parit H.	Kuala Kurau.	Parit Hall Wabab.	Kampung Kedah.						
Klebang Kacili	10	11	12	13	14	15	16	17	18	19	20	21
Hygroscopic moisture and salts dissolved	2.10	5.50	9.80	6.20	8.20	8.20	4.50	6.80	3.50	10	11	12
Humus	2.70	3.40	3.30	2.90	2.90	2.40	3.10	2.90	4.10	13	14	15
Clay	6.60	14.10	14.80	11.20	12.40	10.30	8.70	11.10	14.20	16	17	18
Fine silty	23.90	33.60	35.50	31.60	33.20	27.30	28.40	25.30	33.00	19	20	21
Silt	18.00	28.70	20.60	28.40	24.30	23.80	28.40	25.30	33.00	22	23	24
Fine sand	46.20	14.70	20.60	20.70	19.80	23.00	33.30	27.20	14.90	25	26	27
Coarse sand	0.20	Nil	Nil	Nil	Nil	Nil	Nil	Nil	14.70	28	29	30
Fine gravel	0.40	Nil	Nil	Nil	Nil	Nil	Nil	Nil	14.70	31	32	33
Coarse gravel	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	14.70	34	35	36
Water absorption	58.0	69.0	60.0	65.0	89.0	90.0	89.0	71.0	70.0	37	38	39

Moisture	0.800	5.200	8.500	5.300	7.800	7.800	4.200	6.200	3.700	40	41	42
Organic matter and combined water	1.400	10.600	4.000	2.080	4.000	3.860	1.920	2.400	1.700	43	44	45
Oxide of iron and manganese	0.200	0.900	0.800	0.800	0.800	0.800	0.800	0.800	0.800	46	47	48
Oxide of alumina	5.023	18.138	15.827	14.702	15.838	18.058	9.356	14.034	12.234	49	50	51
Lime	0.240	0.180	0.380	0.280	0.380	0.320	0.240	0.40	0.200	52	53	54
Magnesia	0.168	0.173	0.922	0.432	0.677	0.634	0.605	0.49	0.374	55	56	57
Potash	0.113	0.367	0.875	0.268	0.618	0.644	0.330	0.816	0.203	58	59	60
Sulphuric anhydride	0.161	0.096	0.274	0.696	0.710	0.233	0.206	0.233	0.082	61	62	63
Phosphoric acid	0.077	0.077	0.900	0.077	0.090	0.070	0.077	0.077	0.064	64	65	66
Chlorine	0.014	0.028	0.400	0.025	0.060	0.051	0.051	0.051	0.030	67	68	69
Silicates	9.044	60.189	37.348	37.168	39.390	40.321	44.606	64.776	47.030	70	71	72
Uncombined nitrogen	0.120	0.185	0.292	0.168	0.213	0.258	0.140	0.140	0.183	73	74	75
Lower oxide of iron	0.045	0.045	0.204	0.204	0.204	0.170	0.170	0.170	0.163	76	77	78
Reaction P. H.	4.7	4.6	Good	Fair	Good	Good	Fair	Fair	Fair	79	80	81
Humus	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	82	83	84
Phosphoric acid	0.0045	0.0045	0.005	0.005	0.006	0.0077	0.006	0.005	0.005	85	86	87
Chlorine	0.0058	0.006	0.006	0.006	0.009	0.009	0.009	0.009	0.009	88	89	90

Moisture	0.800	5.200	8.500	5.300	7.800	7.800	4.200	6.200	3.700	91	92	93
Organic matter and combined water	1.400	10.600	4.000	2.080	4.000	3.860	1.920	2.400	1.700	94	95	96
Oxide of iron and manganese	0.200	0.900	0.800	0.800	0.800	0.800	0.800	0.800	0.800	97	98	99
Oxide of alumina	5.023	18.138	15.827	14.702	15.838	18.058	9.356	14.034	12.234	100	101	102
Lime	0.240	0.180	0.380	0.280	0.380	0.320	0.240	0.40	0.200	103	104	105
Magnesia	0.168	0.173	0.922	0.432	0.677	0.634	0.605	0.49	0.374	106	107	108
Potash	0.113	0.367	0.875	0.268	0.618	0.644	0.330	0.816	0.203	109	110	111
Sulphuric anhydride	0.161	0.096	0.274	0.696	0.710	0.233	0.206	0.233	0.082	112	113	114
Phosphoric acid	0.077	0.077	0.900	0.077	0.090	0.070	0.077	0.077	0.064	115	116	117
Chlorine	0.014	0.028	0.400	0.025	0.060	0.051	0.051	0.051	0.030	118	119	120
Silicates	9.044	60.189	37.348	37.168	39.390	40.321	44.606	64.776	47.030	121	122	123
Uncombined nitrogen	0.120	0.185	0.292	0.168	0.213	0.258	0.140	0.140	0.183	124	125	126
Lower oxide of iron	0.045	0.045	0.204	0.204	0.204	0.170	0.170	0.170	0.163	127	128	129
Reaction P. H.	4.7	4.6	Good	Fair	Good	Good	Fair	Fair	Fair	130	131	132
Humus	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	133	134	135
Phosphoric acid	0.0045	0.0045	0.005	0.005	0.006	0.0077	0.006	0.005	0.005	136	137	138
Chlorine	0.0058	0.006	0.006	0.006	0.009	0.009	0.009	0.009	0.009	139	140	141

Mechanical Composition.

Hygroscopic moisture and salts dissolved

Humus

Clay

Fine silty

Silt

Fine sand

Coarse sand

Fine gravel

Coarse gravel

Water absorption

Chemical Composition.

Moisture

Organic matter and combined water

Oxide of iron and manganese

Oxide of alumina

Lime

Magnesia

Potash

Sulphuric anhydride

Phosphoric acid

Chlorine

Silicates

Uncombined nitrogen

Lower oxide of iron

Reaction P. H.

Humus

Phosphoric acid

Chlorine

Chemical Composition.

Moisture	0.800
Organic matter and combined water	1.440
Oxide of alumina	5.923
Lime	0.240
Magnesia	0.378
Soda ash	0.113
Rock salt	0.151
Salphuric anhydride	0.096
Phosphoric acid	0.090
Silicic acid	0.025
Containing nitrogen	0.108
Equal to ammonia	0.120
Lower oxide of iron	4.7
Free iron P. H.	4.7
Humus	Good
Citric soluble phosphoric acid	0.0045
Citric soluble potash	0.0053

Table F.

Serial No.	District.	Elevation.	Rainfall, Average.	Irrigation	Yield per Acre.	Fertilizers.	Broadcasted or Transplanted.	Quantity of Seed.	Variety.
1.	Kuala Lipis	.. About 350 ft.	88 in.	.. By stream	.. 1,000 lb.	.. No	.. Transplanted	.. 16 lb.	.. Gansar
2.	Kuala Lipis	.. About 300 ft.	88 in.	.. Stream	.. 1,750 lb.	.. No	.. Transplanted	.. 16 lb.	.. Radin and Pulut
3.	Kuala Lipis	.. 300 ft.	.. 88 in.	.. Stream	.. 1,750 lb.	.. —	.. Transplanted	.. 16 lb.	.. Jambut
4.	Raub	.. 450 ft.	.. 88 in.	.. Stream	.. 9,000 lb.	.. —	.. Transplanted	.. 15 lb.	.. Salak Niah
5.	Raub	.. 450 ft.	.. 88 in.	.. Stream	.. 2,250 lb.	.. —	.. Transplanted	.. 16 lb.	.. Radin Niah
6.	Raub	.. 450 ft.	.. 88 in.	.. Stream	.. 2,250 lb.	.. —	.. Transplanted	.. 16 lb.	.. Radin Antah
7.	Kuala Pilah	.. 280 ft.	.. 54 in.	.. Water wheel	.. 1,500 lb.	.. —	.. Transplanted	.. 30 lb.	.. Serendah
8.	Kuala Pilah	.. 280 ft.	.. 54 in.	.. Water wheel	.. 1,500 lb.	.. —	.. Transplanted	.. 30 lb.	.. Serendah
9.	Malacca Central	.. 13 ft.	.. 57.7 in.	.. Rain	.. 2,500 lb.	.. Grasses and burnt buffalo's bones	.. Transplanted	.. 35-40 lb.	.. Pulut Hitam
10.	Malacca Central	.. 13 ft.	.. 62.7 in.	.. Rain	.. 2,500 lb.	.. bones and burnt mud, and burnt buffalo's bones	.. Transplanted	.. 36 lb.	.. Padi Slam.
11.	Krian	.. 15 ft.	.. 88 in.	.. Rain	.. 1,000-1,250 lb.	.. —	.. Transplanted	.. —	.. Padi Lingg. Machin Putih
12.	Krian	.. 3 ft.	.. 88 in.	.. Yes	.. 2,200-2,250 lb.	.. —	.. Transplanted	.. —	.. Serap and Serap
3.	Krian	.. 5 ft.	.. 88 in.	.. Yes	.. 1,000-1,500 lb.	.. —	.. Transplanted	.. —	.. Serap Kechil
4.	Krian	.. 2 ft.	.. 88 in.	.. Yes	.. 1,000 lb.	.. —	.. Transplanted	.. —	.. Serap Kechil and Radin padi
5.	Krian	.. 3 ft.	.. 88 in.	.. Yes	.. 2,250-2,500 lb.	.. —	.. Transplanted	.. —	.. Besar Kechil and Radin Kechil
6.	Krian	.. 3 ft.	.. 88 in.	.. Yes	.. 1,950-1,500 lb.	.. —	.. Transplanted	.. —	.. Radin Putih
7.	Krian	.. 3 ft.	.. 88 in.	.. Yes	.. 2,250-2,600 lb.	.. —	.. Transplanted	.. —	.. Serap Kechil
8.	Krian	.. 18 ft.	.. 88 in.	.. Yes	.. 1,250-1,500 lb.	.. —	.. Transplanted	.. —	.. Radin Serap Kechil

FEDERATED MALAY STATES AND STRAITS SETTLEMENTS

(Tables VIII. and F.)

[See pages 34, 35, 36, and 37.]

Eighteen soil samples were examined from the Federated Malay States and the Straits Settlements. The soils were obtained from Kuala Lipis, Raub, Kuala Pilah, Malacca Central, and Krian Districts. The soils generally are gravelly silts with varying proportions of clay.

Kuala Lipis District.

Three samples of soil were examined from this district.

No. 1, Pengon.—The soil from this area is charged with organic matter, which has rendered it extremely acid, P. H. 5.1. As with other soils of this type, there is a large proportion of clay 24 per cent. and silts 57 per cent., and a small proportion of the coarse fraction 8 per cent., giving the soil mass difficult drainage; this is noted in the high water absorption 82 per cent.

The nitrogen, 0.711 per cent., is very rich compared with the soils under comparison. The mineral plant food is in good reserve.

Elevation, 350 feet. Rainfall, 88 inches. Irrigation given from a running stream. Sowing rate is 15 lb. with ordinary seed, the seedlings are transplanted to the field. No manuring is given. Yield 1,000 lb.

No. 2, Budu.—A much coarser type than No. 1. Coarse material 58 per cent., silt 30 per cent., clay 8 per cent., water retention 60 per cent., the soil mass being more free draining than No. 1. Reaction is slightly acid, P. H. 7.2.

The nitrogen is low. The mineral plant food is in fair reserve.

Elevation, 300 feet. Rainfall, 88 inches. Irrigation as in No. 1. Sowing as in No. 1. Yield 1,750 lb.

No. 3, Tanjong Besar.—Similar to No. 2. Coarse material 55 per cent., silts 37 per cent., clay 6 per cent., water retention 52 per cent. Reaction is acid, P. H. 6.1.

Plant food is in fair reserve. Other details as in No. 2.

Raub District.

Three samples of soil were examined from this district, from Segu, Dong, and Gali. The samples obtained are more silty than those from Kuala Lipis.

No. 4, Segu.—Half the weight of the surface soil is obtained from silts, 49 per cent., clay amounts to 5 per cent., coarse material to 42 per cent., water retention 56 per cent.

The nitrogen is in better supply than in Nos. 2 and 3, but the mineral plant food is less. The soil is acid, P. H. 6.8

Elevation, 450 feet. Rainfall 88 inches. Sowing as in other districts. Yield 2,000 lb.

No. 5, Dong.—This area has more clay (10 per cent.), less silt (44 per cent.), less coarse material 38 per cent. than No. 4, water retention (82 per cent.) is high. The soil is sour, P. H. 6.7.

Plant food is fair. Selected seed is used. Yield 2,250 lb. Other materials as above.

No. 6, Gali.—This area has more clay (12 per cent.), more silt (56 per cent.), and less coarse material (20 per cent.) than the other soils of the district, water retention 60 per cent. The soil is very sour, P. H. 4.9.

The nitrogen is rather poor. The mineral plant food is fair other details as in No. 5. Ordinary seed used.

Kuala Pilah District.

Two samples were examined from this district. There is more coarse material in this district than the others.

No. 7, Mukim Ulu Muar.—Coarse material amounts to 39 per cent., silts 44 per cent., clay 13 per cent., water retention 78 per cent. The soil is acid P. H. 5.5.

The nitrogen is rather poor. The mineral plant food is in good supply.

Elevation, 280 feet. Rainfall, 54.4 inches. Irrigation when required.

Selected seed is used at the rate of 10 lb. Yield 1,500 lb. Other details as above.

No. 8, Mukim Sri Monanti.—A coarse type. Clay amounts to 6 per cent., silts to 27 per cent., coarse material to 65 per cent., water retention 56 per cent. The soil is very sour, P. H. 5.2.

Sowing rate 25 lb. Yield 500 lb. Other details as in No. 7.

Malacca Central District.

Two samples were examined from this district. The soils contain nearly equal proportions of silts and coarse material.

No. 9, Semabok.—Coarse material amounts to 35 per cent., silts 50 per cent., clay 10 per cent., retention of water 62 per cent. The soil is very sour, P. H. 4·9.

The plant food is in good supply. Selected seed is sown at rate 35–40 lb. and transplanted. Yield 2,500 lb. Elevation, 13 feet. Rainfall, 57·7 inches. Grasses are used for mulching and burnt buffalo bones for manure.

No. 10, Klebang Kachil.—This area has about equal proportions of silts (42 per cent.) and coarse material (47 per cent.) and 6 per cent. of clay. Water absorption 58 per cent. The nitrogen is rather poor, but the rest of the plant food is in fair supply. The soil is very sour, P. H. 4·7. Elevation, 13 feet. Rainfall, 62·7 inches. Selected seed is sown at rate 35 lb., transplanted, manured with grasses, sea mud, and burnt buffalo bones. Yield 2,500 lb.

Krian District.

Eight samples were examined from this district. The soils contain more silts and less coarse matter than the other districts.

No. 11, Simpang Ampat.—Contains more silt (62 per cent.), than the other soils from Federated Malay States and Straits Settlements. Coarse matter amounts to 15 per cent., clay 14 per cent. Water retention 69 per cent. The soil is very sour, P. H. 4·6.

Plant food generally is in good supply. Elevation, 15 feet. Rainfall, 88 inches. Yield 1,000–1,250 lb.

No. 12, Tanjong Piai.—Coarse material amounts to 16 per cent., silts 56 per cent., clay 15 per cent. Water retention is high at 90 per cent. Reaction is acid, P. H. 6·1.

There is a good reserve of all plant food. Elevation, 3 feet. Rainfall, 88 inches. Irrigation is given.

Ordinary seed is used. Yield 2,500 lb.

No. 13, Parit H.—Coarse material amounts to 21 per cent., silts 60 per cent., clay 11 per cent., water retention 65 per cent. Soil is very sour, P. H. 4·8.

The plant food is in good reserve.

Ordinary seed is sown. Yield 1,250 lb.

No. 14, Kuala Kuran.—This soil is similar to No. 13, but has a higher water absorption (89 per cent.), is richer in plant food, and gives a yield of 1,300 lb. Soil is slightly acid, P. H. 6·8.

No. 15, Parit Haji Wahab.—This soil is similar to Nos. 13 and 14, has fair reserves of plant food. Yield 2,400 lb. from selected seed. The soil is slightly acid, P. H. 6·9.

No. 16, Kampong Kedah.—This soil is a coarser type than above. Coarse material amounts to 39 per cent., silts 47 per cent., clay 7 per cent., water retention 89 per cent., which is high. The soil is very sour, P. H. 4·4.

Plant food is in good reserve. Selected seed is used. Yield 1,400 lb.

No. 17, Titi Serong.—Similar to No. 15 in mechanical composition. Water absorption is lower at 71 per cent. Soil is very sour, P. H. 4·7.

Plant food is in good reserve. Yield 2,400 lb. from selected seed.

No. 18, Metang Pasir.—A coarse clay silt. Coarse material amounts to 35 per cent., silts 43 per cent., clay 14 per cent., water absorption 70 per cent. The soil is very acid. P. H. 4·8.

Plant food is in good reserve. Ordinary seed is used giving a yield of 1,400 lb. per acre. Elevation, 18 feet. Rainfall, 88 inches. Irrigation is given.

GENERAL REMARKS ON FEDERATED MALAY STATES AND STRAITS SETTLEMENTS PADDY SOILS.

The Krian District has less coarse gravel (average 25 per cent.) and more silts (average 54 per cent.) than the other districts. Clay (average 12 per cent.) is higher than the other districts, except Kuala Lipis, due to one soil Pengon containing 24 per cent. Water absorption is also higher in the Krian Districts (average 79 per cent.). Kuala Pilah District contains more coarse material than the other districts (average 52 per cent.). This district also contains least silts (average 25 per cent.). The grand average of the Federated Malay States and Straits Settlements soil samples comes to coarse material 34 per cent., silts 48 per cent., clay 11 per cent., water absorption 71 per cent.

The nitrogen is very rich, (0·711 per cent.) in Pengon-Kuala Lipis Districts ; poor in Budu, (0·101 per cent.) of the same district, Gali (0·106 per cent.) of Raub District, Mukim Ulu Muar (0·101 per cent.) and Mukim Sri Monanti (0·106 per cent.) of Kuala Pilah District, Klebang Kachil (0·106 per cent.) of Malacca Central District.

Lime is rather poor in comparison in Segu, Raub (0·160 per cent.) ; Mukim Sri Monanti, Kuala Pilah (0·160 per cent.) ; Simpang Ampat, Krian (0·180 per cent.). Magnesia is comparatively poor in Pengon, Kuala Lipis (0·130 per cent.) ; Segu (0·130 per cent.), Dong (0·058 per cent.), Gali (0·072 per cent.). Raub District ; Mukim Ulu Muar (0·144 per cent.), Mukim Sri Monanti (0·101 per cent.), Kuala Pilah ; Semabok 0·158 per cent.), Klebang Kachil (0·158 per cent.), Malacca Central ; Simpang Ampat (0·173 per cent.), Krian. Magnesia is high in Tanpong Piandang (0·922 per cent.), Krian. Potash is comparatively poor in Segu (0·178 per cent.), Dong (0·167 per cent.), Raub, rich in Tanpong Piandang (0·772 per cent.), Kuala Kuran (0·819 per cent.), and Titi Serong (0·695 per cent.) of Krian, and is richer all round in this district compared with the others as with the other mineral plant food. Available potash is not very rich in any of the districts. Phosphoric acid is richer in the Kuala Lipis District than the others. Available phosphoric acid is not high in any of the districts.

The grand average for the Federated Malay States and Straits Settlements is : Nitrogen 0·132 per cent., lime 0·270 per cent., magnesia 0·336 per cent., potash 0·438 per cent., available potash 0·008 per cent., phosphoric acid 0·074 per cent., available phosphoric acid 0·005 per cent., soils are sour, P. H. 4·4-6·9.

Elevation varies from 3 to 450 feet. Rainfall from 54 inches to 88 inches. Irrigation is given.

Selected seed were used in the case of Nos. 5, 7, 8, 9, 10, 15, 16, and 17, ordinary seed in the case of others. 10-40 lb. of seed are used. Transplanting is customary. Manuring is not generally carried out, except in Nos. 9 and 10. Yield varies from 500 lb. at Mukim Sri Monanti, Kuala Pilah, to 2,500 lb. in Semabok and Klebang Kachil in Malacca Central, deleting the first, the average yield for the Federated Malay States and Straits Settlements is 1,800 lb. per acre. The higher yields in Nos. 9 and 10 may be due to selected seed being used and the manuring given.

Table IX.

Table IX.																		
	Serial No.	Coarset.		Slit.		Clay.		Water Absorption		Nitro- Lins.		Magnesia.		Potash.		Oleic		Yield, per Acre.
		Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.		
<i>Mandila.</i>																		
2	100	1	1	24	11	65	65	0.005	2.72	1.325	0.463	0.018	0.115	0.017	1,800	..	1,500	
10-80	100	1	1	24	11	65	65	0.005	2.72	1.325	0.463	0.018	0.115	0.017	1,800	..	1,500	
22-60	100	1	1	24	11	65	65	0.005	2.72	1.325	0.463	0.018	0.115	0.017	1,800	..	1,500	
51-80	100	1	1	24	11	65	65	0.005	2.72	1.325	0.463	0.018	0.115	0.017	1,800	..	1,500	
Average	100	1	1	24	11	65	65	0.005	2.72	1.325	0.463	0.018	0.115	0.017	1,800	..	1,500	
1-100	100	1	1	24	11	65	65	0.005	2.72	1.325	0.463	0.018	0.115	0.017	1,800	..	1,500	
82-00	100	1	1	24	11	65	65	0.005	2.72	1.325	0.463	0.018	0.115	0.017	1,800	..	1,500	
<i>Alibang, Rital.</i>																		
2	100	1	1	24	11	65	65	0.005	2.72	1.325	0.463	0.018	0.115	0.017	1,800	..	1,500	
10-80	100	1	1	24	11	65	65	0.005	2.72	1.325	0.463	0.018	0.115	0.017	1,800	..	1,500	
22-60	100	1	1	24	11	65	65	0.005	2.72	1.325	0.463	0.018	0.115	0.017	1,800	..	1,500	
51-80	100	1	1	24	11	65	65	0.005	2.72	1.325	0.463	0.018	0.115	0.017	1,800	..	1,500	
Average	100	1	1	24	11	65	65	0.005	2.72	1.325	0.463	0.018	0.115	0.017	1,800	..	1,500	
1-100	100	1	1	24	11	65	65	0.005	2.72	1.325	0.463	0.018	0.115	0.017	1,800	..	1,500	
82-00	100	1	1	24	11	65	65	0.005	2.72	1.325	0.463	0.018	0.115	0.017	1,800	..	1,500	

Table G.

Serial No.	District	1	2
Elevation	..	Allaga-Nueva Ecija	..
Rainfall	..	50 ft.	..
Irrigation	..	69-14 in.	..
Yield per acre	..	Yes, Casual	..
Measures	..	1,862 lb.	..
Broadcast or transplanted	..	No	..
Quantity of seed	..	Transplanted	..
Variety	..	46-2 lb.	..
	..	"Minabon "	..
	..	"Aposol "	..

Table X.

Material No.	Silt.		Clay.		Water Absorption.		Nitro-ge-n.		Lime.		Magnesia.		Potash.		Citric Phos.		Yield per Acre.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	
1	108	45	31	65	0.434	0.26	0.24	0.108	0.017	0.051	0.003	..	960	..	1,600	..	1,600
2	49	39	60	60	0.283	0.23	0.31	0.145	0.017	0.036	0.005	..	1,600	..	1,600	..	1,600
3	42	38	62	62	0.200	0.07	0.28	0.142	0.016	0.053	0.009	..	685	..	1,600	..	1,600
4	30	55	7	64	0.150	0.36	0.20	0.077	0.005	0.008	0.003	..	1,600	..	1,600	..	1,600
5	4	52	25	58	0.220	0.41	0.30	0.100	0.024	0.041	0.004	..	..	..	..	..	..
6	5	37	35	65	0.390	0.11	0.09	0.187	0.004	0.078	0.006	..	2,400	..	1,475	..	1,475
7	12	53	20	55	0.160	0.42	0.56	0.182	0.022	0.048	0.023	..	..	..	..	..	..
8	48	48	27	60	0.248	0.27	0.23	0.131	0.014	0.047	0.007	..	..	..	..	..	..

Table H.

[illegible]

PHILIPPINE ISLANDS.

(Tables IX. and G.)

[See page 43.]

Two typical paddy soils were obtained from the Philippine Islands; they are both coarse silts with 12 to 16 per cent. of clay present. The coarse material varies from 40 to 51 per cent., silts 24 to 44 per cent., clay averages 13 per cent., water retentive power averages 60 per cent., and varies from 55-65 per cent.,

Nitrogen is poor (0.098 per cent.). Mineral plant food is generally in good supply. Lime averages 1.88 per cent., and varies from 1.04 per cent. to 2.72 per cent. Magnesia varies from 0.677 to 1.325 per cent., and averages 1.001 per cent. Potash is in good reserve, averages 0.405 per cent., varies 0.347 per cent. to 0.463 per cent. Available potash averages 0.016 per cent. Phosphoric acid averages 0.109 per cent., with an availability of 0.015 per cent. Reaction is nearly neutral.

Yield varies from 1,500-1,900 lb.; average 1,700 lb. Seed is selected or ordinary sown at the rate of 46 lb. and transplanted. The fields are not manured.

Elevation varies from 50 feet to 80 feet. Rainfall 55 inches to 69 inches. Irrigation is given.

SIAM.

(Tables X. and H.)

[See page 44.]

Siam paddy soils are clay silts. The coarse material averages 8 per cent., silts 48 per cent., clay 27 per cent. No. 4 is a different type to the others, with less clay (7 per cent.) and more coarse material (30 per cent.). Water absorption averages 60 per cent.

Nitrogen on average is high (0.248 per cent.). Nos. 4 and 7 have poorer nitrogen than the others. (0.150 per cent. and 0.160 per cent., respectively). Lime averages 0.27 per cent. Nos. 3 and 6 are poorer in lime than the others (0.07 per cent.) and 0.11 per cent., respectively). Magnesia averages 0.28 per cent., is poor in No. 6 (0.09 per cent.). Potash averages 0.131 per cent., is poorer in No. 1 (0.106 per cent.), No. 4 (0.077 per cent.), No. 5 (0.100 per cent.). Available potash averages 0.014 per cent. Phosphoric acid averages 0.047 per cent., is low in No. 4 (0.008 per cent.). Available phosphoric acid averages (0.007 per cent.) is poor in Nos. 1 and 4, (0.003 per cent. and 0.002 per cent., respectively).

Elevation about 5 feet. Rainfall 41 to 46 inches. No. 3 has 71 inches. No irrigation is given, but the fields are subject to flood inundations for about one month's duration.

Yields vary up to 2,400 lb. per acre in No. 7, 1,600 lb. in Nos. 2, 3, and 5, in No. 1 960 lb., 685 lb. in No. 4. No manure is applied. Ordinary seed is broadcasted at the rate of 100 lb. per acre.

JAPAN.

(Tables XI. and J.)

[See page 47.]

Four soil samples were examined from Japan. They are mostly coarse silts with small proportions of clay. No. 4 is different from the other three in the larger proportion of clay and the smaller proportion of sand. The coarse soil matter (sand and gravel) varies from 36 per cent. in No. 4 to 59 per cent. in No. 3 (average 52 per cent.). Nos. 1, 2, and 3 are similar. Silts vary from 28 per cent. in No. 3 to 37 per cent. in No. 2 (average 32 per cent.). Clay varies from 24 per cent. in No. 4 to 3 per cent. in No. 1 (average 10 per cent.). The plant food is in fair reserve. Nitrogen varies from 0.123 per cent. in No. 4 to 0.286 per cent. in No. 1 (average 0.179 per cent.). Lime varies from 0.120 per cent. in No. 2 to 1.04 per cent. in No. 1 (average 0.465 per cent.). Magnesia averages 0.288 per cent. and varies from 0.115 per cent. to 0.432 per cent. in Nos. 1 and 4. Potash averages 0.430 per cent., and varies from 0.270 per cent. in No. 1 to 0.540 per cent. in No. 3. Available potash averages 0.017 per cent., and varies from 0.013 per cent., in No. 1 to 0.022 per cent. in No. 4. Phosphoric acid averages 0.176 per cent., and varies from 0.102 per cent. in No. 4 to 0.243 per cent. in No. 2. Available phosphoric acid varies from 0.009 per cent. in No. 4 to 0.021 per cent. in No. 2 (average 0.017 per cent.). No. 1 is slightly acid, P. H. 6.5; Nos. 2, 3, and 4 are more or less neutral, 6.8-7.2 P. H.

Elevation is 66 to 83 feet. Rainfall 47-59 inches. Irrigation is given. Seed is planted at the rate of 22 lb. and transplanted from the nursery. Manure is used up to 4 tons per acre, consisting largely of bulk manure, such as farm-yard manure or green manure, supplemented with soya bean cake, fish guano, and chemical manures, super, ammonium sulphate, &c. Yield varies, from 1,785 lb. in Nos. 1 and 2 to 3,570 lb. in No. 3.

Table XI.

Serial No.	Coarse.	Silt.	Clay.		Water.		Nitro.		Lime.		Magnesia.		Potash.		Citric.		Phos.		Acid.		Yield per Acre	
			Per	Cent.	Per	Cent.	Per	Cent.	Per	Cent.	Per	Cent.	Per	Cent.	Per	Cent.	Per	Cent.	Per	Cent.	lb.	lb.
Chiba	1	37	32	3	66	0.286	1.040	0.432	0.270	0.013	0.230	0.018	0.230	0.018	0.230	0.018	0.230	0.018	0.230	0.018	2,200	2,200
Kagawa	2	55	37	4	60	0.168	0.120	0.115	0.388	0.015	0.248	0.021	0.248	0.021	0.248	0.021	0.248	0.021	0.248	0.021	9,000	9,000
Ehimeken	3	35	28	8	55	0.140	0.440	0.178	0.540	0.017	0.128	0.020	0.128	0.020	0.128	0.020	0.128	0.020	0.128	0.020	2,647	2,647
Atchiken	4	36	30	24	58	0.173	0.460	0.238	0.430	0.017	0.178	0.017	0.178	0.017	0.178	0.017	0.178	0.017	0.178	0.017	2,647	2,647
Average	—	52	32	10	58	0.173	0.460	0.238	0.430	0.017	0.178	0.017	0.178	0.017	0.178	0.017	0.178	0.017	0.178	0.017	2,647	2,647

Table J.

Serial No.	District	Elevation	Rainfall	Irrigation	Yield per acre	Manures	1	2	3	4
							Tokyo	South Japan	Ehimeken	Atchiken
2-400	59-06 in.	47-21 in.	53-47 in.	66 ft.
7-000	1,785-2,678 lb.	1,785-2,678 lb.	8,570 lb.	59-06 lb.
3-040	Barn yard manure	Barn yard manure	Summer Crop	200
10-601	Plum guano	Superphosphate	Soy bean	200
0-260	Superphosphate	Wood ash	Cotton seed	20
0-322	Superphosphate and straw	..	Conc. super.	10
0-020	per ton
0-103	per ton
0-017	per ton
14-644	per ton
0-123	per ton
0-150	per ton
0-009	per ton
0-009	per ton
0-022	per ton

Broadcasted or
planted
Quantity of seed
Variety

Transplanted
22 lb.
"Hordium Coeleste"
"Oryza Sativa"

Transplanted
22 lb.
"Hordium Coeleste"

per ton
1,953.8 lb.
7,821 lb. per acre

COMPARISON OF PADDY SOILS EXAMINED FROM CEYLON AND OTHER COUNTRIES.

	Coarse.		Silt.		Clay.		Water Absorption.		Nitrogen.		Lime.		Magnesia.		Potash.		Phosphoric Acid.		Citric Phosphate.		Yield, per Acre.		Matured.		Elevation.		Rainfall.		Transplanted.		Selected.		Rate.		Alkaline.		
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Ceylon Averages*	63	24	7	48	0.184	0.285	0.351	0.314	0.016	0.114	0.012	1,060	Yes	6-1800	38-150	Not often	No	90-113	Yes																		
South India	52	20	10	51	0.070	1.398	0.801	0.618	0.019	0.169	0.017	2,700	Yes	20-1200	13-45	Yes	Yes	20-90	Yes																		
Burma	14	55	21	66	0.112	0.600	1.127	0.921	0.018	0.138	0.012	2,000	No	100-300	40-80	Yes	Ordinary	40-80	Yes																		
Federated Malay Settlements	34	48	11	71	0.132	0.270	0.336	0.438	0.008	0.074	0.005	1,800	No	3-450	54-88	Yes	Both	10-40	No																		
Siam	8	48	27	60	0.248	0.270	0.280	0.181	0.014	0.047	0.007	1,475	No	50-80	52-46	Yes	Both	48	No																		
Philippine Islands	45	32	18	50	0.088	0.351	0.381	0.445	0.017	0.176	0.017	2,047	Yes	65-72	47-59	Yes	Both	48	No																		
Japan	..	..	..	58	0.176	0.465	0.286	0.430	0.017	0.176	0.017	2,047	Yes	65-72	47-59	Yes	Both	48	No																		

* Excluding pioneer lands and exceptional Matara District.

† Hambantota deleted from average.

COMPARISON OF PADDY SOILS FROM CEYLON WITH SOILS
FROM OTHER COUNTRIES.

(Tables V. and XII.)

In the observations given below pioneer areas (Minneriya, Nachchaduwa, Karachchi) and the exceptional Matara District have been eliminated from the average, and only areas actually under paddy cultivation in Ceylon have been taken for comparison with established paddy lands of other countries.

It is observed that Ceylon paddy soils contain a larger percentage of coarse soil (fine gravel, coarse, and fine sand) than paddy soils from other countries. The average coarse matter in Ceylon paddy soils is 63 per cent. For other countries, the coarsest is South India (52 per cent.) Japan (52 per cent.), Philippine Isles (45 per cent.); other countries have much less coarse matter.

The silt fraction average of Ceylon paddy soils examined is 24 per cent., which compares with South India, 29 per cent. In Burma, Federated Malay States, and Straits Settlements, and Siam it is the predominating fraction (48 to 55 per cent.).

Clay is not present in large proportions in any of the soils examined, except Burma (21 per cent.), Siam (27 per cent.). The Ceylon average clay fraction is 7 per cent. In the exceptional Matara District clay averages 26 per cent., in the other Provinces there is no outstanding percentage of clay found. In Japan the clay fraction is 5 per cent., in the others 10 to 13 per cent.

The retention power of water of Ceylon paddy soils (48 per cent.) compares with South India (51 per cent.). Other countries are higher due to the larger proportion of silts and clay and the lower proportion of "coarse" (gravel and sands). It is important for irrigable lands to be able to retain water added and supplement natural precipitation. Free draining soils do not hold water in their soil mass, and much of it is lost agriculturally. Irrigation of such lands is expensive, due to the quick seepage.

Nitrogens found in the soils examined indicate that it is not a predominating factor in the cultivation of paddy. None of the paddy soils have a large percentage of nitrogen. Ceylon average for nitrogen is 0.184 per cent., deleting the pioneer areas and the exceptional Matara (Southern Province) soils, which are very high in nitrogen (0.579 per cent.). Siam is highest of the series (0.248 per cent.); South India lowest (0.070 per cent.).

The reason for the paucity of organic matter and nitrogen in paddy soils is that they are dissipated as gases. Anaerobic fermentation takes place in the water-logged soil mass. Gases given off, due to the decomposition of the organic matter in the soil (mainly cellulose from vegetable residues), are marsh gas (CH_4) and carbon dioxide (CO_2); due to a film of organisms occurring on the surface of the soil, the marsh gas is changed into carbonic acid (H_2CO_3), and in turn to oxygen. At the surface of the soil the gases evolved are oxygen and nitrogen; the oxygen aerates the roots. Soil conditions are not suitable for nitrification, being anaerobic, but the reverse, denitrification, and release of free unused nitrogen; for this reason nitrates, such as sodium nitrate, should never be used for paddy manuring, resort should be made to organic manures, such as cattle and green manures, cakes, ammonium sulphate, &c., when required.

Lime averages 0.285 per cent. in the Ceylon soils, eliminating the exceptional Hambantota (Southern Province) (0.938 per cent.), which with North-Western (0.310 per cent.) and Eastern Province (0.497 per cent.) are above the average; the other Provinces are below it (0.140 to 0.282 per cent.). South India and the Philippine Isles are very rich in lime (1.398 per cent. and 1.88 per cent., respectively). Burma (0.600 per cent.) and Japan (0.465 per cent.) come next in order, and are above the Ceylon average. Federated Malay States and Straits Settlements and Siam have 0.270 per cent. of lime, approximate the Ceylon average.

Magnesia averages 0.351 per cent. in the Ceylon paddy soils. The Provinces falling below the average are Matara (Southern Province) (0.11 per cent.) and Western Province (0.087 per cent.). The Hambantota (Southern Province) (0.513 per cent.) and the Eastern Province (0.495 per cent.) are above the average. Burma (1.127 per cent.), the Philippine Isles (1.001 per cent.), and South India (0.801 per cent.) are much above the Ceylon average. The other countries are below the Ceylon average in magnesia.

Potash average for Ceylon is 0.314 per cent. Hambantota (Southern Province) 0.450 per cent., Central Province 0.321 per cent., Eastern Province 0.417 per cent. are above the Ceylon potash average, the other Provinces are below the average (0.170 to 0.176 per cent.). Burma soils are rich in potash (0.921 per cent.), South India follows (0.618 per cent.). Siam (0.131 per cent.) is the only country which has a poorer potash average than Ceylon. Available potash averages 0.016 per cent. in Ceylon. The North-Western (0.009 per cent.) and Western Provinces (0.0085 per cent.) are below the

average. Federated Malay States and Straits Settlements (0·008 per cent.) soils are below the Ceylon average for available potash.

Phosphoric acid averages 0·114 per cent. The Hambantota (Southern Province) (0·178 per cent.) and Western Province (0·154 per cent.) are above this average; the other Provinces are below it (0·070 to 0·088). The Federated Malay States and Straits Settlements (0·074 per cent.), Siam (0·047 per cent.), and Philippine Isles (0·109 per cent.) are below the Ceylon average in phosphoric acid; the other countries are above it.

Available phosphoric acid average 0·012 per cent. The North-Western Province (0·005 per cent.) is below the average. Federated Malay States and Straits Settlements (0·005 per cent.) and Siam (0·007) are below the Ceylon average for available phosphoric acid.

Generally speaking, paddy soils are not rich in organic matter and nitrogen, but have a good reserve of mineral plant food. The soils are generally alkaline, Matara (Southern Province) is an exception to this. Some of the areas are neutral. Federated Malay States and Straits Settlements and Siam soils are sour.

The elevation of the paddy soils examined in Ceylon varies from practically sea level up to 1,600 feet in the Central Province. In other countries elevation varies from practically sea level to 1,200 feet in South India.

Rainfall in Ceylon at places of sampling varies from 38 inches in the Hambantota (Southern Province) area to 150 inches in Galle District of the Southern Province. In the other countries from 13 inches in South India to 88 inches in the Federated Malay States and Straits Settlements. Irrigation is given when required.

In Ceylon, except in the Central Province and parts of Kegalla and Matara, ordinary seed is broadcasted at the rate of 90 to 113 lb. In Burma ordinary seed is sown in nurseries at the rate of 40 to 50 lb. and transplanted. In South India selected seed is sown in nurseries at the rate of 20 to 90 lb. and transplanted. In the Federated Malay States and Straits Settlements both ordinary and selected seed are used in different districts at the rate of 10 to 40 lb., and transplanting from the nurseries takes place. In the Philippine Isles transplanting takes place after sowing in nurseries at the rate of 46 lb., both ordinary and selected seed are used. In Japan the sowing rate is 21·5 lb., transplanting takes place. Siam broadcasts the seed, 100 lb. per acre. The chief difference in

method of sowing between Ceylon, Siam and other countries is that the latter use less seed for propagation purposes, and transplants the seedlings from the nurseries to the fields.

Yields obtained are highest from South India at 2,700 lb., next Japan at 2,600 lb., then Burma at 2,000 lb., Federated Malay States and Straits Settlements at 1,800 lb., Philippine Isles at 1,700 lb., Siam 1,475 lb., and Ceylon at 1,060 lb. The two highest yielding countries, South India and Japan, manure their fields; the other countries do not. Some of the Ceylon districts manure their fields, but not so intensively as Japan does. The quantity of manure used by Japan is 3 to 4 tons per acre per annum.

If the two heaviest yielders of paddy, South India and Japan, be taken and the conditions examined, it is found that soil conditions are more nearly approached by the soil conditions of the Southern Province than the other Provinces of Ceylon. Selected seed is sown in nurseries and transplanted in the fields in South India and Japan; in Ceylon the seed is generally broadcasted. Both South India and Japan manure their paddy fields, Japan heavily. Ceylon manure paddy to a certain extent.

DEDUCTIONS AND RECOMMENDATIONS.

The Ceylon soils are poor in their powers of water retention and in the finer soil particles. Greater attention should be given therefore, to prepare the land before the crop is sown. Ploughing will break up the soil mass and help to increase the proportion of fine soil for the paddy to feed on. It will also make the soil mass retentive of moisture.

Green manuring should be more generally practised. This will improve the quantity of organic matter in the soil, and will assist the soil mass in retaining irrigation water and rains.

Manuring should also be extended preferably with phosphates, such as bones, cheap finely ground rock phosphates, &c.

Where possible, the wasteful methods of broadcasting seed at a high seed rate should cease, and the more economical method of sowing seed in nurseries and the transplanting of seedlings should be practised.

Attention should also be given to the selection of seed, for thereby crops can be readily increased.

The chief fault of the Ceylon soils that have been examined is the small proportion of fine soil, silts, and clay on which the plants feed, and on which to a great extent the drainage power of the soil mass depends. The proportion of plant food in the fine soil is not actually deficient, but requires to be greatly increased to make up for the poor proportion of fine

soil or volume of feeding surface, which is deficient has been clearly demonstrated by Russel (*J. Soc. Royal Agric. Eng.*, Volume 80, 1919), on the cultivation of waste lands of the United Kingdom during the war, when importation of foods was difficult and waste lands were brought into cultivation. In the article referred to rainfall comes into Russel's arguments, as no irrigation scheme was available, that point can be dismissed for Ceylon. Russel's conclusions are that waste lands with a poor proportion of fine silts and clay can be cultivated economically, provided high intensive cultivation is carried out. What is true of these lands is also true of Ceylon lands, those already under paddy cultivation and potential paddy producers.

Thanks are due to the officers of the Department of Agriculture of the Madras Presidency, Burma (Mr. Warth), Federated Malay States and Straits Settlements (Mr. Eaton), Siam (Mr. Ladell for analyses), Philippine Isles, Japan, and to the Agricultural Instructors of the Department of Agriculture, Ceylon, for collecting and sending soil samples, and for giving all the particulars required.

Colombo, May, 1922.

ALEXANDER BRUCE.

